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"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH

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INDEX.

NAME INDEX.

Abderhalden (Prof. E.), awarded the Berzelius medal, 414
Abel (O.), The Methods of Palæobiological Research, 578
Abell (Sir Westcott S.), Sea Casualties and Loss of Life, 511
Abetti (G.), Comparison between Visual and Photographic Observations of Nebulæ, 390
Adamson (A.), appointed Lecturer in Physics in the Faculty of Technology of Manchester University, 262
Adcock (F.), The Electrolytic Etching of Metals, 198
Agamennone (G.), The World's Earthquakes in 1916, 390
Alexander (T.), and J. T. Jackson, Polygons to Generate Diagrams of Maximum Stress, 421
Alkins (W. E.), and W. Cartwright, Effect of Progressive Cold-drawing upon some of the Physical Properties of Low-tin Bronze, 198
Allen (Dr. H. S.), Faraday and the Quantum, 341
Allen (Dr. J. A.), [death], 94; [obituary article], 475
Ancaster (Earl of), to act as Deputy Minister of Fisheries, 316
Andrade (J.), Spiral Cylinders and the Hypothesis called *des techniciens*, 357
Andrewes (Sir F. W.), and Sir Cuthbert Wallace, appointed to the Medical Research Council, 190
Andrews (S. T. G.), and S. F. Benson, The Theory and Practice of Aeroplane Design, 36
Annandale (Dr. N.), Applied Anthropology, 370; Indian Land Mollusca, 180, 340
Anspach (Dr. B. M.), Gynecology, 206
Appleton (A. B.), D. G. Reid, A. Hopkinson, and V. C. Pennell, appointed demonstrators in Anatomy in Cambridge University, 195
Arambourg (C.), Discovery of a Fossil Scopeloid Fish of the Genus Myctophum, 576
Arldt (Th.), The Methods of Palæogeography, 578
Armellini (Prof. G.), The Origin of Comets, 447
Armitage (Capt. C. H.), presented with the Silver Medal of the Zoological Society of London, 477
Armstrong (Prof. F. E.), [death], 315; [obituary article], 346
Armstrong (Prof. H. E.), Is Scientific Inquiry a Criminal Occupation? 241; and C. A. Klein, Paints, Painting, and Painters, 225
Arrhenius (Prof. S.), Traduction française par T. Seyrig. Le Destin des Etoiles: Etudes d'Astronomie Physique 207
Arthus (M.), awarded the Marcel Benoist Prize, 190
Artom (C.), Cytological Data on the Tetraploidism of *Artemia salina* from the District of Margherita di Savoia, in Apulia, 391
Ashworth (Prof. J. H.), The British Association at Edinburgh, 44
Atha (J. W.) & Co., The Development of Optical Industries, 238
Atkins (Dr. W. R. G.), Finger-and-Toe Disease of Turnips in Relation to the Hydrogen-ion Concentration of the Soil, 485; Relation of the Hydrogen-ion Concentration of the Soil to Plant Distribution, 80, 485; The Differentiation of Boiled and Unboiled Water, 339; The Hydrogen-ion Concentration of Plant-cells, 485; The Hydrogen-ion Concentration of the Soil in Relation to Animal Distribution, 568
Aubel (E. van), The Influence of Temperature on the Viscosity of Normal Liquids, 32
Aveling (Rev. F. A. P.), appointed Reader in Psychology at King's College, London, 293
Azumbuja (M. d'), A Method for the Synchronisation of Clock Mechanism and of Pendulums employed in Astronomy, 199

Baillie-Grohman (W. A.), [obituary article], 475
Bainbridge (Prof. F. A.), [death], 315; [obituary article], 344
Bairstow (Prof. L.), Address to the National Union of Scientific Workers, 380; Miss B. M. Cave, and Miss E. D. Lang, The Two-dimensional Slow Motion of Viscous Fluids, 356; and Major A. G. Church, Safeguarding of Industries Act, 1921, 271
Baker (C. H.), Gift to Bristol University, 354
Ball (W. W. Rouse), String Figures. Second Edition, 175
Balls (Dr. W. L.), The Smoke-veil, 499
Baly (Prof. E. C. C.), Absorption Spectra, 311; Prof. I. M. Heilbron, and W. F. Barker, The Photosynthesis of Formaldehyde and Carbohydrates from Carbon Dioxide and Water, 290; The Synthesis of Formaldehyde and Carbohydrates from Carbon Dioxide and Water, 354
Bamford (T. G.), The Density of the Zinc-Copper Alloys, 198
Bancroft (Prof. W. D.), Research Problems in Colloid Chemistry, 586
Banks (B. G.), and L. G. Laws, awarded Scholarships by the Salters' Institute, 166
Barker (A. H.), Domestic Fuel Consumption, 560
Barker (R. G.), appointed Scientific Director of the British Launderers' Research Association, 414
Barkla (Prof. C. G.), The Energy of X-radiation, 449
Barnard (J. E.), Microscope Illumination and Fatigue, 468, 566
Barnett (E. de Barry), Anthracene and Anthraquinone, 108; and P. C. L. Thorne, Organic Analysis, Qualitative and Quantitative, 564
Barr (J.), appointed Manager of the Yarn-testing Bureau at University College, Nottingham, 71
Bartrum (C. O.), Reflection from Cylindrical Surfaces, 436
Bateson (W.), Classical and Modern Education, 64
Bather (Dr. F. A.), Biological Terminology, 271; Echinoderm Larvæ and their Bearing on Classification, 459, 530; Scientific Publication, 144
Baudouin (M.), A Method for the Determination of the Minerals constituting Prehistoric Metallic Axes, 422; The Material Representation on Stone of the Constellation of the Great Bear, belonging to the Polished Stone Period, 325
Bauer (Dr. L. A.), Measurements of the Electric and Magnetic Activity of the Sun and the Earth and Interpretations, 446
Bayliss (Prof. W. M.), Integration in the Living Organism, 537

Baynes (R. E.), [death], 94
Bearpark (A. F.), The Whaling Industry, 191
Beaven (E. S.), Gift of Silver Bowl to, 543
Beckinsale (S.), The Magnesium Alloy "Electron," 198
Bedford (Sir C. H.), appointed Honorary Adviser to the Secretary of State for the Colonies on Power and Industrial Alcohol, 25
Beebe (W.), A Monograph of the Pheasants (in four volumes). Vol. ii., 235
Belaiew (Col. N. T.), Damascene Steel, 248
Bennett (H. H.), The Soils and Agriculture of the Southern States, 7
Bensusan (S. L.), State Aid and the Farmer, 416
Berger (E.), and G. Crut, The Equilibrium in the Reduction of Nickel Chloride by Hydrogen, 486
Bergstrand (Prof. O.), The Effective Wave-length of the Light of Galactic Stars, 480
Berry (A.), re-appointed University Lecturer in Mathematics in Cambridge University, 292
Berthelot (A.), and Mlle. E. Ossart, Researches on the Micro-organisms producing Acetone, 389
Bertin (L.), The Habit of Feigning Death among Animals, 224
Bertrand (G.), and Mme. M. Rosenblatt, The Distribution of Manganese in the Organisms of the Higher Plants, 517
Berwick (W. E. H.), appointed Reader in Mathematical Analysis in Leeds University, 588; elected to a Fellowship at Clare College, Cambridge, 419
Bevan (E. J.), [obituary article], 314
Bews (Prof. J. W.), Some Aspects of Botany in South Africa and Plant Ecology in Natal, 551
Bezssonnof (N.), A Colour Reaction common to Anti-scorbutic Extracts and Hydroquinone, 135; The Anti-scorbutic Principle in Potato-juice extracted in Presence of Acids, 135
Bhagwat (Prof. V. K.), Calculations in Organic Chemistry, 564
Biffen (Prof. R. H.), Gift of Silver Bowl to, 543
Bijl (P. van der), appointed Professor of Phytopathology and Mycology in the University of Stellenbosch, 71
Blackaby (J. H.), appointed Assistant Lecturer in Physics in Manchester University, 262
Blackman (Dr. F. F.), awarded a Royal Medal by the Royal Society, 380
Blackman (Miss W. S.), The Mourning Rites of Mussulmans in Asyut, Egypt, 95
Blackman (Prof. V. H.), Plant Diseases and their Relation to Diseases in Man, 289
Blake (S. F.), Sexual Differences in Colour in the Spotted Turtle, 444
Blaringhem (L.), The Production of the "Marbled Varieties" of the Bean *Vicia Faba*, 326
Bledisloe (Lord), Potatoes and Pigs with Milk as the Basis of Britain's Food Supply, 393
Boas (F.), The Influence of Environment upon Development, 263
Bodansky (M.), The Distribution of Zinc in the Organism of the Fish, 389
Bohn (G.), Le Mouvement Biologique en Europe, 563
Bohr (Prof. N.), Atomic Structure, 208; awarded the Hughes Medal of the Royal Society, 380; elected an Honorary Member of the Royal Institution, 477
Bolas (B. D.), A Handbook of Laboratory Glass-blowing, 464
Bolton (Dr. C.), awarded the William Julius Mickle Fellowship, University of London, 293
Boncour (P.), appointed Professor of Criminal Anthropology at the Ecole d'Anthropologie, Paris, 324
Bouchet (L.), The Variation with Time of the Pressures created in Insulating Fluids by a Constant Electrostatic Field, 454
Bourget (H.), [obituary article], 412
Bourne (Prof. G. C.), The Raninidæ, a Study in Carcinology, 590
Bousfield (W. R.), Some Problems in Evolution, 530
Boutan (L.), The Nucleus of Fine Pearls, 389
Boutroux (E.), [death], 413; [obituary article], 441
Boutroux (Prof. P.), L'Idéal Scientifique des Mathématiciens: Dans l'Antiquité et dans les Temps Modernes, 427
Bouvier (E. L.), and R. Roidor, Appearance of Males and Females in the Nests of the Field-ant and the Tawny Ant of the Upper Jura, 294
Bower (Prof. F. O.), elected President of the Royal Society of Edinburgh, 287
Bowman (I.), The Andes of Southern Peru: Geographical Reconnaissance along the Seventy-third Meridian, 78
Boycott (Prof. A. E.), Sinistral *Limnaea peregra*, 403
Boyle (Prof. J. E.), Agricultural Economics, 79
Boys (Prof. C. V.), The Apparatus of Dr. Russ, 40
Brady (Dr. G. S.), [death], 575
Braithwaite (R.), Bequest to Liverpool University, 262
Brauner (Prof. B.), Atomic Weights, 479; The "Proletarisation of Science" in Russia, 367
Brazier (C. E.), The Resistance of the Air to the Movement of Spheres, and the Rate of Ascent of Pilot Balloons, 325; Variation of the Velocity of Ascent of Pilot Balloons with Altitude, 389
Brentano (J. C. M.), The Measurement of Ionisation Currents by Three-electrode Valves, 532
Bridel (M.), The Action of Emulsin from Almonds on Lactose in 85 per cent. Ethyl Alcohol, 199; and Mlle. Marie Braecke, The Presence of a Glucoside Hydrolysable by Emulsion in Two Species of the Genus Melampyrum, 135
Bridgman (P. W.), Further Measurements of the Effect of Pressure on Resistance, 294
Brierley (Dr. W. B.), Scientific Publication, 41; The Actinomycetes, 397
Briggs (H.), Prehensility, a Factor of Gaseous Adsorption, 485; The Military Physical Test Station, Edinburgh, 486
Briggs (Dr. S. H. C.), Qualities of Valency, 306
Bristowe (W. S.), The Insect and Arachnid Fauna of Jan Mayen, 554
Brodetsky (Dr. S.), Aeronautics, 36; Dander's Airman's International Dictionary, 111; Cusack's The Arithmetic of the Decimal System, 174; Kite Balloons, 111; Thomas's Notes on Dynamics, 207
Broglie (M. and L. de), The Corpuscular Spectra of the Elements, 230
Brooks (C. E. P.), Could the Drought of 1921 have been Forecasted?, 351; The Last Glacial Epoch, 351; Variations of Climate since the Ice Age, 90
Brotherton (Sir Edward Allen), Gift to Leeds University, 229
Brown (Prof. Baldwin), The *rationale* of Primitive Art, 583
Brown (Prof. T. Graham), A Curious Physiological Phenomenon, 529
Brown (Dr. W.), The Physiology of the Infection Process 325
Browne (C. E.), Laboratory Designs, 140
Browning (Prof. K. C.), The Development of Optical Industries, 305
Bruce (Brig.-Gen. the Hon. C.), acceptance of the Leadership of the Mount Everest Expedition, 414
Bruce (Dr. W. S.), [death], 315; [obituary article], 345
Bruni (G.), and C. Pelizzola, Presence of Manganese in Grey Rubber and Cause of "Tackiness" (*peciosità*), 390; and E. Romani, Mechanical Action of Certain, Vulcanising Accelerants of Rubber, 389
Bryce (G.), Brown Bast and the Rubber Plant, 81
Buchanan (F.), Muscular Piezo-electricity?, 340
Buckley (Dr. A. C.), The Basis of Psychiatry, 362
Buckley (Dr. J. P.), appointed Lecturer in Regional Surgery in the University of Manchester, 553
Buckman (S. S.), Jurassic Chronology: II., Preliminary Studies, 589; Type Ammonites, 481
Bugnon (P.), The Theory of Syncotylia and the Case of *Streptopus amplexifolius*, 326
Bunsen (Sir Maurice de), University Relief for Central Europe and Russia, 435
Burgess (Dr. G. K.), Tests of Six Hollow Cylindrical Steel Castings manufactured by the Centrifugal Process, 69
Burkitt (M.), Painting of Palæolithic Age found in a Pyrenean Cave, 584

Burns (C. D.), appointed Lecturer in Philosophy at Birkbeck College, 166
Burns (Dr. D.), appointed Professor of Physiology in the University of Durham College of Medicine, 134
Burton-Opitz (Dr. R.), Advanced Lessons in Practical Physiology for Students of Medicine, 143
Burtt-Davy (J.), The Distribution of Salix in South Africa, 516
Bury (H.), The Generation of Heath-fires, 83
Butler (E. J.), Meteorological Conditions and Disease, 515
Bütschli (Prof. O.), Vorlesungen über vergleichende Anatomie. 3 Lief.: Sinnesorgane und Leuchtorgane, 236
Butterworth (S.), Earth Capacity Effects in Alternating-current Bridges, 388; The Use of Anderson's Bridge for the Measurement of the Variations of the Capacity and Effective Resistance of a Condenser with Frequency, 388
Buxton and Hort, The Pottery Industry of Malta, 129

Cady (W. G.), Use of Carborundum for Ruling Test Plates, 370
Cahen (O.), A New Aerial Float, 263
Calderwood (W. L.), Sex-change in the Native Oyster, 272
Calmette (A.), L. Négre, and A. Bouquet, Tuberculous Antibodies, 486
Cambage (R. H.), Acacia Seedlings, 199
Camichel (C.), Hydraulic States of Flow, 325
Campbell (Prof.), The Total Solar Eclipse of September 1922, 291
Campbell (Dr. Norman R.), Metaphysics and Materialism, 399; Relativity and Materialism, 569
Carline (G. R.), The Open-air Museums of Sweden, 483
Carmina (B. M.), Aviation: Theoretico-Practical Textbook for Students, 36
Carpenter (Prof. H. C. H.), and Constance Elam, The Production of Single Crystals of Aluminium and their Tensile Properties, 356
Carr (Prof. H. Wildon), Metaphysics and Materialism, 247, 400; Relativity and Materialism, 467
Carter (H. J.), Australian Coleoptera: Notes and New Species, 231
Carter (J. C.), The Electric Telegraph, 568
Case (J.), The Theory of Direct-current Dynamos and Motors, 461
Casson (S.), A Journey through Macedonia, 584
Cave (C. J. P.), The Cloud Phenomenon of November 29, 1920, 453
Caven (Dr. R. M.), Qualities of Valency, 210
Cavendish (the Hon. Henry), The Scientific Papers of, Vol. 1: The Electrical Papers, edited by Prof. J. Clerk Maxwell. Revised by Sir Joseph Larmor Vol. 2: Chemical and Dynamical, edited by Sir Edward Thorpe, with Contributions by Dr. C. Chree, and others, 4
Chadwick (Dr. J.), elected to a Fellowship at Gonville and Caius College, 386
Chance (E. P.), A Kinematograph Film of the Cuckoo disposing its Eggs, and Behaviour of its Young, 415, 421
Chapman (A. Chaston), A Proposed National Institute of Industrial Micro-biology, 425; appointed a Member of the Royal Commission on Awards, 223; Micro-organisms and some of their Industrial Uses, 187
Chapman (Dr. T. A.), [death], 542
Chappell (A. J.), appointed Assistant Lecturer in Mechanical Engineering in Sheffield University, 262
Chappuis (J.), and Hubert-Desprez, Researches on Stray Currents, 454
Charlesworth (Dr. J. K.), appointed Professor of Geology in Queen's University, Belfast, 166; resignation of the Senior Lectureship in Geology in Manchester University, 262
Charlier (Prof. C. V. L.), elected an Honorary Member of the American Astronomical Society, 190
Charpy (G.), and G. Decorps, The Determination of the Degree of Oxidation of Coal, 422
Chatelier (H. le), Berechtigte Uebersetzung, Dr. H. Finkelstein, Kieselsäure und Silicate, 138
Chaworth-Musters (J. L.), The Vegetation of Jan Mayen, 554
Chemin (E.), The Corrosive Action of Plant Roots on Marble, 486
Chisholm (G. G.), and others, The Teaching of Geography, 260
Choulant (L.), Translated and Edited by Dr. M. Frank. History and Bibliography of Anatomic Illustration in its Relation to Anatomic Science and the Graphic Arts, 141
Chree (Dr. C.), Simultaneous Values of Magnetic Declination at Different British Stations, 510
Christmas (W. D.), Rainfall Records at Rothamsted, 307
Christy (Miller), Habits of the Hedgehog, 242; The Problem of the Pollination of our British Primulas, 516
Clarke (J. R.), The Effect of Rays from Radium, X-rays, and Ultra-violet Light on Glass, 290
Claude (G.), The Manufacture of Hydrogen by the Partial Liquefaction of Water Gas, 325
Clayton (W.), The Need for Research in Colloid Chemistry, 586
Clerc (L.-P.), Aerid Photography and Photo-topography, 292
Clibbens (Dr. D. A.), The Principles of the Phase Theory. Heterogeneous Equilibria between Salts and their Aqueous Solutions, 171
Clifford (F. W.), British Scientific and Technical Books, 462
Cobb (Prof. J. W.), Fuel Problems and Prospects, 18
Cockerell (Prof. T. D. A.), The Dispersal of Snails by Birds, 496
Cole (Prof. G. A. J.), Earth-structure, 236; Geography in Austria, 100
Coles (Dr. A. C.), Critical Microscopy: How to get the best out of the Microscope, 39
Collie (Prof. J. N.), and Miss A. Reilly, The Preparation of a New Type of Iodine Compound, 417
Collins (Marjorie I.), The Mangrove and Saltmarsh Vegetation near Sydney, with special reference to Cabbage Tree Creek, Port Hacking, 517
Comber (N. M.), Relation of the Hydrogen-ion Concentration of the Soil to Plant Distribution, 146
Compton (Prof. A. H.), The Magnetic Electron, 97; The Softening of Secondary X-rays, 366
Constantin and Dufour, Researches on the Biology of the Monotropa, 486
Cook (Dr. W. G. H.), Insanity and Mental Deficiency in Relation to Legal Responsibility: A Study in Psychological Jurisprudence, 143
Cooper (P. A.), resignation of, as Lecturer in Physics in Manchester University, 323
Cope (W. H.), retirement of, from the Librarianship of Birmingham University, 134
Core (C. G.), re-appointed a Schunk Research Assistant in Manchester University, 323
Cortie (Rev. A. L.), Aurora Borealis, Terrestrial Magnetic Disturbances, and Sunspots, 272
Cortini (Dr. J. C.), *Tylomyces gummiparus*, n. sp., the Prototype of a New Genus of Hyphomycetes, i., 391
Cottle (C. L.), Forthcoming Expedition to Sumatra, 128
Cotton (Dr. L. A.), Earth Movements at Burrinjuck, as recorded by Horizontal Pendulum Observations, 199
Coupin (H.), The Contribution of the Seed to the Adult Plant, 294
Courrier (R.), The Determination of the Secondary Sexual Characters in the Arthropods, 326
Cousins (Dr. J. W.), [obituary], 221
Coward (Dr. H. F.), elected Chairman of the Chemical Section of the Manchester Literary and Philosophical Society, 477
Coward (K. H.), and J. C. Drummond, Fish and their Store of Vitamin, 192

Coward (T. A.), The Growth of the Manchester Museum, 479; The Preservation of our Fauna, 513
Cowie (Lt.-Col. H. McC.), A Criticism of R. D. Oldham's "The Structure of the Himalayas and the Gangetic Plain," 254
Crawley (W. C.), and H. A. Baylis, Mermis parasitic on Ants of the Genus Lasius, 453
Crewe (Marquess of), and others, The Safeguarding of Industries Act and the German Reparation (Recovery) Act, 380
Crossland (C.), The Use of Hebrew at the Jewish University in Jerusalem, 387
Crommelin (Dr. A. C. D.), Arrhenius's Le Destin des Etoiles, 207; awarded the G. de Pontécoulant Prize, 223; Sôtome's Astronomical Time-keepers and Time-preserving Systems, 175; The Outline of Science: A Plain Story Simply Told, edited by Prof. J. Arthur Thomson, 463
Crowfoot (Mrs. I. W.), Spinning and Weaving in the Sudan, 67
Cunningham (Dr. J. T.), Biological Terminology, 368
Curie (M.), The Action of the Infra-red Rays on Phosphorescence, 263
Curle (A. O.), The Earthworks and Settlements on Traprain Law, 584
Curtis (W. E.), appointed Reader in Physics at King's College, London, 293
Cusack (Dr. J.), The Arithmetic of the Decimal System, 174

Dade (H. A.), appointed Assistant Mycologist in the Department of Agriculture, Gold Coast, 190
Damant (Lt.-Comdr. G. C. C.), Illumination of Plankton, 42
Damiens (A.), Tellurium Sub-bromide, 294
Dander (M. M.), Airman's International Dictionary: including the Most Important Technical Terms of Aircraft Construction, English, French, Italian, German, 111
Danjon (A.), Photometric Study of the Eclipse of the Moon of October 16–17, 1921, 357
Dannatt (F. C.), A Curious Physiological Phenomenon, 529
Darwin (C. G.), and others, The Quantum Theory, 449
Dauvillier (A.), Analysis of the Atomic Structure, 516
Davies (T. A.), awarded the Earl of Durham Prize of the Institution of Naval Architects, 25
Dawson (Dr. W. Bell), The Bright Object Near the Sun, 193
Deane (Rev. W.), Fijian Society: or, The Sociology and Psychology of the Fijians, 139
Dejean (P.), The Demagnetising Field of Cylindrical Bars of Mild Steel, 325; The Transformation of Iron at the Curie Point, 135
Delépine (Prof. A. S.), [death], 379; [obituary article], 412
De Marchi (L.), Thermal Gradient and Vertical Acceleration in the Atmosphere; 390
Dendy (Prof. A.), The Stream of Life, 84
Dendy-Marshall (C. F.), The Liverpool and Manchester Railway, 446
Denham (H. G.), The Bismuth Sub-salts, 295
Denham (H. J.), Microscope Illumination and Fatigue, 369, 496; The Fall of Seeds of Forest Trees and Resistance of the Air, 416
Denning (W. F.), Bright Assemblage of Morning Stars, 384; Conjunction of Venus and Mars, 164; Fireballs, 511; Large Fireball, 226; Large Meteors, 28; September Meteors, 131; November Meteors, 319; December Meteors, 447; January Meteors, 580; The Leonid Meteor Shower, 417; The Markings on Jupiter, 547
Denny (C. W.), The Electro-deposition of Copper and its Industrial Applications, 564
Denton (F. M.), Elementary Principles of Continuous-current Armature Winding, 465
Desch (Prof. C. H.), Metallurgical Principles and Processes, 562
Desgrez, Guillemard, and Hemmerdinger, Individual Protection against Carbon Monoxide: Reagent and Apparatus, 294
De Stefani (C.), Fossil Sponges, VIII, 390
De Toni (Prof.), Manuscripts relating to Leonardo da Vinci, 577
Dewhurst (C. B.), appointed Dean of the Faculty of Science in the University of Manchester, 553
Dhar (N. R.), and N. N. Mittra, Induced Reactions and Negative Catalysis, 516
Dixon (E. E. L.), The Geology of the South Wales Coalfield. Part 13: The Country around Pembroke and Tenby, 257
Dixon (Prof. H. B.), impending retirement of, 514
Dixon (Prof. H. H.), The "Ghost Micrometer," 350; and N. G. Ball, Photo-synthesis and the Electronic Theory, II., 590
Dodds (J. M.), [death], 380; [obituary article], 506
Dodwell (H. H.), appointed Professor of the History and Culture of British Dominions in Asia at the School of Oriental Studies, 552
Donnan (Prof. F. G.), The Impurity of Pure Substances, 298
Donop (Lt.-Col. P. G. von), [obituary], 413
Doodson (Dr.), and others, Researches on Tides, 418
Dorsey (N. E.), The Designation of the Radium Equivalent, 40
D'Ossat (G. De A.), Solubility of Leucite in Agricultural Soil, 390
Dowling (J. J.), and C. J. Haughey, The Electrification of Smoke Nuclei from Phosphorus, 554
Doyle (K. D.), Agriculture and Irrigation in Continental and Tropical Climates, 7
Drugman (Dr. J.), Porphyry-quartz from the Esterel Mountains (France) twinned on the Face ($10\bar{1}2$), 388
Duane (W.), H. Fricke, and W. Stenström, The Absorption of X-rays by Chemical Elements of High Atomic Numbers, 326; and R. A. Patterson, Characteristic Absorption of X-rays, L Series, 294; The Relative Positions and Intensities of Lines in X-ray Spectra, 294; and W. Stenström, The K Series of X-rays, 263
Ducie (Earl of), [obituary], 315
Duclaux (J.), and P. Jeantet, The Absorption Spectrum of Oxygen, 294
Duerden (Prof.), Problems of Race and Nationality, 551
Dufraisse (C.), and P. Gérald, The Supposed True Dibenzoylmethane of Wislicenus: Some New Experiments, 486
Dunoyer (L.), The Induction Spectrum of Rubidium, 167
Dunstan (B.), The Stones in a Casket presented to the Prince of Wales by the State of Queensland, 289
Duthie (Miss A. V.), The Morphology of *Selaginella pumila*, 518
Dyson (Sir Frank), awarded a Royal Medal by the Royal Society, 380; elected Master of the Clockmakers' Company, 223

Eales (Nellie B.), Aplysia, L.M.B.C. Memoirs, No. 24, 398
Earle (K. W.), The Lower Carboniferous Rocks of West Cumberland, 485
Eastham (L.), appointed Lecturer in Zoology in Birmingham University, 195
Eastwood (E. H.), appointed Demonstrator in Pathology and Bacteriology in Sheffield University, 262
Eastwood (T.), The Lead and Zinc Ores of the Lake District, 445
Eblé (E.), The Periodicity of the Microseismic Agitation. 555
Eddington (Prof. A. S.), The Dynamical Equilibrium of the Stellar System, 480
Eder (Dr. J. M.), A New Dye-printing Photographic Process, 383
Edwards (P.), The Nature of Vowel Sounds, 82
Elles (Gertrude L.), The Study of Geological Maps, 301
Elliot (Hugh), Relativity and Materialism, 432
Elmhirst (R.), Breeding Periods of Newt and Slow-worm, 179
Emerson (Dr. F. V.), Agricultural Geology, 7
Emin Pascha (Dr.), Die Tagebücher von, Band 6, 397
Erinoid, Ltd., Cornalith and Galalith, 130
Errera (J.), Contribution to the Knowledge of the Cuprous Compounds, 230

Evans (A. G.), awarded the Raymond Horton Smith Prize, 292
Evans (Dr. J. W.), The Study of Rocks, 494
Evans (Sir L. Worthington), The Scientific Work of the late Lt.-Col. E. F. Harrison, 347
Evershed (J.), Terrestrial Magnetic Disturbances and Sunspots, 566

Fabre (J. H.), The Story Book of the Fields, 270 ; Purchase of the House and Garden of, as a Memorial, 543
Fabry (Prof. C.), The Luminosity of the Night Sky, 319
Fabry (L.), The Atmospheric Wave produced by the Explosion of the Works at Oppau, 294
Fantham (Prof. H. B.), Some Recent Advances in Zoology and their Relation to Present-day Problems, 551
Fawcett (C. B.), The Population of Urban Areas and Chief Towns, 165
Fawcett (W.), The Banana : Its Cultivation, Distribution, and Commercial Uses. Second edition, 270
Ferguson (E. W.), Revision of the Amycterides. Part vii. : Hyborrhynchus and Allied Genera, 517
Fierz-David (Prof. H. E.), translated by Dr. F. A. Mason, The Fundamental Processes of Dye Chemistry, 138
Findlay (Prof. A.), International Physico-chemical Symbols, 474
Fischer (L. A.), [obituary], 24
Fisher (E. A.), Relation of the Hydrogen-ion Concentration of the Soil to Plant Distribution, 306
Fisher (Prof. I.), Impending Problems in Eugenics, 252
Fisher (R. A.), The Mathematical Foundations of Theoretical Statistics, 421
Fisher (Dr. W. J.), Old Observations bearing on the Duration of Sunrise, 531 ; Table for the Duration of Sunset, 433 ; The Duration of Sunrise and Sunset, 211
Flammarion (C.), Studies of Nebulæ and Clusters, 193
Flattely (F. W.), Some Biological Effects of the Tides, 318
Fleming (Prof. J. A.), The Coming of Age of Long-distance Wireless Telegraphy and some of its Scientific Problems, 448
Fleming (Miss R. M.), The Geographic Aspects of Tradition, 165
Fletcher (Sir Walter M.), The *Rôle* of Physiology, 59
Flett (Dr. J. S.), Experimental Geology, 57
Fleure (Prof. H. J.), Countries as Personalities (Citizens' lecture in connection with the British Association), 573
Forbes (Mrs. Rosita), presented with the Gold Medal of the Antwerp Royal Geographical Society, 316
Ford (E.), The Life-history of the Dog Fishes, 585
Forster (Dr. M. O.), Chemistry of Anthracene, 108 ; The Laboratory of the Living Organism (Presidential Address to the Chemistry Section of the British Association), 56, 243
Foster (Frances A.), bequests to the Massachusetts Institute of Technology and Wellesley College, 102
Fotheringham (Rev. D. R.), Naked-eye Astronomical Work, 288
Fotheringham (Dr. J. K.), Ancient Eclipses (Halley Lecture), 28
Fournier (L.), and L. Guénot, The Treatment of Syphilis by Bismuth, 326
Fox (Sir C. Douglas), [death], 380 ; [obituary article], 412
François-Franck (Prof. Ch.), [obituary article], 314
Frazer (R. W.), [obituary], 476
Fredericq (Prof. L.), to be presented with a Medallion by the University of Liège, 293
French (Dr. J. W.), Prismatic Structure in Optical Glass, 567 ; The Development of Optical Industries, 304 ; The Interocular Distance of Tested Individuals, 510
Freundler (P.), and Mlles. Y. Menager and Y. Laurent, Iodine in the Laminaria, 454
Freyer (Sir Peter J.), [obituary], 94
Fries (Brig.-Gen. A. A.), and Major C. J. West, Chemical Warfare, 492
Frink (R. L.), The Practical Value of the Microscope in Glass Manufacture, 453
Fry (Prof. H. S.), The Electronic Conception of Valence and the Constitution of Benzene, 77
Fujiwhara (Dr. S.), The Natural Tendency towards Symmetry of Motion and its Application as a Principle in Meteorology, 135
Fuller (Sir Bampfylde), The Science of Ourselves (A Sequel to the " Descent of Man "), 525
Furneaux (W. S.), Countryside Rambles, 207

Gahan (Dr. C. J.), *Ophion luteus*, 403
Gamble (J. S.), Flora of the Presidency of Madras. Part 4, Rubiaceæ to Ebenaceæ, 464
Gardiner (Prof. J. Stanley), Black Coral as a Charm for Rheumatism, 505
Garforth (Sir William), [obituary article], 285
Garner (W. E.), The Dushman Equation for the Velocity of a Monomolecular Reaction, 211
Gaster (L.), Recent Progress in Connection with Illumination, 414
Gatenby (Prof. J. Brontë), Hybridity and the Evolution of Species, 469
Gates (Prof. R. Ruggles), Hybridity and the Evolution of Species, 401
Gaubert (P.), The Recrystallisation produced by Annealing, 516
Geddes (Prof. P.), The Edinburgh of To-day, 165
Genders (R.), The Casting of Brass Ingots, 197 ; The Extrusion Defect, 198
Gentil (L.), The Phenomenon of Mounds (*rideaux*) and Solifluction, 103
Gentle (J. A.), F. R. Jones, S. J. Saint, and F. W. Turner, awarded Fellowships for Post-graduate Study by the Salters' Institute, 166
Gibson (Prof' A. H.), Water Power Development (Presidential Address to the Engineering Section of the British Association), 59, 181
Gifford (J. W.), Achromatic One-radius Doublet Eyepieces, 589 ; Bee-sting and Eyesight, 370
Gilchrist (Dr. J. D. F.), elected President of the Royal Society of South Africa, 443 ; The Pectoral Fin of the Sole, *Achirus capensis*, 32
Gildemeister (E.), and Fr. Hoffmann. Second Edition by E. Gildemeister. Translated by E. Kremers. The Volatile Oils. Second Volume, 138
Giles (Dr. P.), address as retiring Vice-Chancellor of Cambridge University, 195
Gilmore (C. W.), Brachyceratops from North-western Montana, 482 ; Carapaces of Turtles in the Ojo Alamo Sandstone of New Mexico, 482
Gill (E. L.), Behaviour in Lizards, 179
Gillman (C.), and P. Nason, Ascent of Kilimanjaro, 508
Giltay (J. W.), The " Optaphé," 510
Giuffrida-Ruggeri (Prof. V.), The First Outlines of a Systematic Anthropology of Asia, 578
Glangeaud (P.), The Complexity of the Volcanic Massif of Cantal and the True Nature of the Puy Mary, 389 ; The Plomb du Cantal, a Large Independent Volcano, covering nearly a third of the Cantal Massif, 454
Glasson (J. L.), Some Peculiarities of the Wilson Ionisation Tracks and a Suggested Explanation, 421
Goddard (R. H.), The Possibilities of the Rocket in Weather Forecasting, 263
Godlewski (Prof. T.), [death], 380
Godwin-Austen (Lt.-Col. H. H.), Indian Land Mollusca, 106 ; Mount Everest, 409
Goldsbrough (Dr. G. R.), Perturbations of Saturn's Rings, 511
Gonnessiat and Renaux, An Asteroid with an Orbit resembling that of a Comet, 454
Goodrich (Prof. E. S.), Heredity, Environment, and Evolution, 57 ; Some Problems in Evolution (Presidential Address to the Zoology Section of the British Association), 404, 531
Goos (Dr. F.), Delineations of the Milky Way, 319
Goudie (Dr. W. J.), appointed James Watt Professor of the Theory and Practice of Heat Engines in Glasgow University, 261

Grabau (Dr. A. W.), Geology of the Nonmetallic Mineral Deposits other than Silicates. Vol. 1, Principles of Salt Deposition, 112
Grafe (V.), Functions of the Plant-organism, 317
Gramont (A. de), and G. A. Hemsalech, The *rôle* of Electrical Actions in the Emission and Appearance of Certain Types of Lines of the Magnesium Spectrum, 230
Grandidier (A.), [obituary], 286
Grandmougin (M.), The Identity of the Dibromoanthraquinone which served for the Synthesis of Alizarine, 357
Grant (Prof.), Dante's Conception of History, 355
Grassi (B.), A Biological Race of Anopheles which do not attack Man, 390 ; Can Malaria be transmitted directly by Anopheles ?, 389
Gray (J.), Cell-division, 554
Gray (Dr. J. A.), The Softening of Secondary X-rays, 435
Greenwood (J. N.), The Effect of Cold Work on Commercial Cadmium, 515
Gregory (Prof. J. W.), The Age of the Earth, 283
Gregory (Sir Richard), The Message of Science (Presidential Address to the Conference of Delegates of Corresponding Societies of the British Association), 61, 533 ; and others, Scientific Men as Citizens, 415
Grey of Falloden (Lord), Address to the Berwickshire Naturalists' Association, 223
Griffith (Dr. A.), elected President of the National Union of Scientific Workers, 381
Gripenberg (Dr. W. S.), The Film-photophone, 307
Grobbelaar (C. S.), Some South African Paramphistomidæ, Fisch, 518
Grossmann (E.), The Motion of the Perihelion of Mercury, 164
Grove-Hills (Col. E. H.), The Tendency of Elongated Bodies to set in the North and South Direction, 403
Groves (J.), Charophyta collected by Mr. T. B. Blow in Ceylon, 421
Grouiller (H.), and J. Ellsworth, New Elements of Light Variation of the Variable Star V V Orionis, 486
Gude (G. K.), The Fauna of British India, including Ceylon and Burma : Mollusca—III. Land Operculates (Cyclophoridæ, Truncatellidæ, Assimineidæ, Helicinidæ), 106
Guéraud (Mlle. Marcelle), The Re-establishment of the Genus Chlorocrepis in the Tribe of the *Chicoraceae compositae*, 357
Guillaume (J.), Observations of the Sun made at the Lyons Observatory, 230, 325
Guillet (L.), The Position of the Metallurgical Industries of Northern and Eastern France, 255 ; The Thermal Treatment of certain Complex Aluminium Alloys, 486
Guldberg (A.), On Correlation, 319
Gunn (J. W. C.), M. Goldberg, and J. H. Ferguson, The Pharmacological Action of *Scilla Cooperi*, Hook. Fil., *S. Rogersii*, Baker, and *S. lanceaefolia*, Baker, 518
Gunn (R. M. C.), appointed Lecturer in Veterinary Anatomy and Surgery in Sydney University, 102
Gurney (J. H.), Early Annals of Ornithology, 268
Guye (Prof. P. A.), awarded the Davy Medal of the Royal Society, 380

H. (J. A.), Scientific Publication, 144
Haagner (A.), South African Mammals : A Short Manual for the Use of Field Naturalists, Sportsmen, and Travellers, 113
Haas (Dr. P.), appointed Reader in Plant Chemistry at University College, London, 293 ; and T. G. Hill, An Introduction to the Chemistry of Plant Products. Vol. 1 : On the Nature and Significance of the Commoner Organic Compounds of Plants. Third edition, 138
Hadow (Sir Henry), Education in Music, 60
Håkonson (M. K.), Om veir og vind i Trondhjem, 512
Hall (E. H.), The Thomson Effect and Thermal Conduction in Metals, 326
Hall (F. W.), The Excavations of Timgad, 349
Hall (T. C. F.), Lead Ores, 268
Haller (A.), and Mme. P. Ramart, The Reduction Products of Dimethylcampholamide, 357
Halliburton (Prof. W. D.), Giants, 128
Halligan (G. H.), The Ocean Currents around Australia, 357
Halsbury (Lord), [death], 506
Hamburger (Prof.), The Permeability of Cells, 545
Hamill (Dr. J. M.), Diet in Relation to Normal Nutrition, 444
Hamilton (G. H.), Observations of Mars at Flagstaff, 447
Hamlin (E. J.), The Effect of Sunlight on Lead Storage Cells ; The Effect of Evaporation on the Efficiency of Lead Storage Batteries, 32
Hann (Prof. J. von), [death], 221 ; [obituary article], 249
Hanson (Dr. D.), and Marie L. V. Gayler, Constitution and Age-hardening of the Alloys of Aluminium with Magnesium and Silicon, 198
Harcourt-Bath (W.), The Highest Inhabited House, 179
Harding (President), Message at Opening of the Radio New York Central Station, 347
Hardy (G. H.), A Preliminary Revision of some Genera belonging to the Diptera Brachycera of Australia, 231
Hargreaves (J.), elected President of the Chaldæan Society ; Work and Progress of the Chaldæan Society, 288
Harkins (Prof. W. D.), The Separation of Chlorine into Isotopes, 209 ; and A. S. Mulliken, The Separation of Mercury into Isotopes, 146
Harley (Dr. J.), [obituary], 575
Harris (A. E.), Ceratium and Pedalion, 340 ; *Ceratium furca* and *Pedalion mirum*, 42
Harris (Prof. F. S.), Soil Alkali: Its Origin, Nature and Treatment, 7
Harrison (B.), [obituary article], 251
Harrison (the late Lt.-Col. E. F.), unveiling of a Memorial to, 347
Harrison (L.), The Pigmentation of Frogs' Eggs, 517
Harrison (T. H.), The Occurrence in N.S.W. of the Perfect Stage of a Sclerotinia causing Brown Rot of Fruits, 591
Harrison (Dr.), and others, British Roses and Hybridity, 99
Hartridge (Dr. H.), A New Method of Testing Microscope Objectives, 421 ; Physical Effects possibly produced by Vision, observed by Dr. Russ, 22 ; The Radiant Spectrum, 467
Harvey (Prof. E. N.), The Nature of Animal Light, 174
Hatfield (C. M.), The Artificial Production of Rain, 313
Haviland (Miss M. D.), The Bionomics of Parasitism in certain Hymenoptera, 554
Hayata (Dr. B.), Icones Plantarum Formosanarum necnon et Contributiones ad Floram Formosanam. Vol. 10, 237
Head (Dr. H.), Release of Function in the Nervous System, 26
Heath (Sir Thomas L.), nominated President of the Mathematical Association, 553
Heldt (H.), The Co-operation of the Dirigible Balloon in Sea-fishing, 517
Hele (Dr. T. S.), appointed a University Lecturer in Biochemistry in Cambridge University, 292
Hemmy (A. S.), The Flow of Viscous Liquids through Slightly Conical Tubes, 388
Hercus (E. O.), and Prof. T. H. Laby, Notes on Colloidal State, etc., 387
Herdman (Prof. W. A.), Edinburgh and the Rise of Oceanography (an Evening Discourse to the British Association), 308
Herelle, d', Our Knowledge of the "Bacteriophage," 252
Heron-Allen (E.), and E. Earland, *Verneuilina polystropha* and some other Foraminifera, 70
Herring (Prof. P. T.), Dr. R. Burton-Opitz's Advanced Lessons in Practical Physiology for Students of Medicine, 143
Hesselberg (Th.), Om betydningen av, at der i Skandinavien oprettes aerologiske stationer, 513
Hewitt (the late Dr. C. G.), Report of the Dominion Entomologist and Consulting Zoologist for 1917–18, 261
Hewitt (I.), Relics of a pre-Bushman Race, 545
Hewitt (Dr. P. C.), [obituary article], 188
Heywood (H. B.), Bees and Scarlet-runner Beans, 147
Hichens (W. L.), Labour, Capital, and Wages, 58

Hicks (Prof. G. Dawes), Prof. G. T. Ladd, 23
Higginbotham (Miss Lucy), re-appointed a Schunk Research Assistant in Manchester University, 323
Highfield (J. S.), The Education of an Engineer, 381
Hill (Dr. A. W.), Account of a Visit to the Cameroons and Nigeria, 253, 454; The Botanic Gardens, Victoria, Cameroons Province, Nigeria, 377
Hill (G. F.), *Coptotermes Raffrayi*, Wasman (fam. Termitidæ), 104; New and Rare Australian Termites, with Notes on their Biology, 591
Hillhouse (Dr. P. A.), appointed John Elder Professor of Naval Architecture and Marine Engineering in Glasgow University, 261
Hilton (Prof. H.), Determination of the Optic Axes of a Crystal from Extinction-angles, 388; Manning's Primitive Groups, Part 1, 39
Hilton-Simpson (M. W.), A Primitive Water-clock in use in Algeria, 583
Hinard (G.), and R. Fillon, The Chemical Composition of the Starfish, 454
Hind (Lt.-Col. W.), Goniatites at Kniveton, Derbyshire, 481
Hjort (Dr. J.), elected an Honorary Member of the Royal Institution, 477
Hoare (C. A.), Scientific Publication, 179
Hodges (S. A.), awarded the Scholarship of the Institution of Naval Architects, 25
Hogarth (Dr. D. G.), Applied Geography (Presidential Address to the Geography Section of the British Association), 58, 120
Hogben (Dr. L. T.), Preliminary Account of the Spermatogenesis of Sphenodon, 388
Holland (Sir Thomas), the resignation of, from the post of Minister of Industries, India, 160, 189
Holmes (Dr. A.), Petrographic Methods and Calculations, with some Examples of Results achieved, 494
Holweck (M.), Critical Potentials relative to the K and L_1 Discontinuities of the Absorption of Aluminium, 357
Hooker (R. H.), The Functions of a Scientific Society, with Special Reference to Meteorology, 135
Hooper (Comdr. S. C.), The Lafayette Super-high Power Radio Station, 317
Hooton (E. A.), and C. C. Willoughby, Excavation of an Indian Village Site and Cemetery near Madisonville, 252
Hopkins (Prof. F. G.), Oxidation and Oxidative Mechanisms in Living Tissues, 353
Hopwood (F. L.), An Auto-stroboscope and an Incandescent Colour Top, 589
Horwood (A. R.), A New British Flora: British Wild Flowers in their Natural Haunts, Vols. 3–6, 205
Houstoun (Dr. R. A.), The Present Position of the Wave Theory of Light, 13, 61
Howe (Prof. G. W. O.), appointed Superintendent of the Electrical Department of the National Physical Laboratory, 71; appointed James Watt Professor of Electrical Engineering in Glasgow University, 261
Howes (C. J. A.), Catalogue of Tapa or Bark-cloth acquired by the Pennsylvania University Museum, 96
Howley (Prof. J.), Psychology and Mystical Experience, 525
Hudson (Prof. R. G.), Engineering Electricity, 461
Hull (Dr. G. F.), The Applications of Physics to Ordnance Problems, 290
Hulme (E. W.), elected to the Sandars Readership in Bibliography and Palæography in Cambridge University, 195
Hume (Dr. W. F.), and F. Hughes, The Soils and Water Supply of the Maryut District, West of Alexandria, 585
Hunt (H. A.), A Rain Map of Australia for 1920, 27
Huxley (J. S.), Evidences of Variation and Evolution as they occur in Nature, 252; The Accessory Nature of Many Structures and Habits associated with Courtship, 565; The Inheritance of Acquired Characters, 289
Hyde (Dr. E. P.), elected President of the International Illumination Commission, 195
Hyman (H.), appointed Ferguson Fellow for Research in Applied Chemistry, 589
Iguchi (K.), The Races of Japanese Domestic Cattle, 383
Imms (Dr. A. D.), E. D. Sanderson's Insect Pests of Farm, Garden and Orchard. Second Edition, 495
Imperial Tobacco Co., Ltd., Gift to Bristol University, 354
Inchley (Dr. O.), appointed Assistant to the Downing Professor of Medicine, Cambridge University, 261
Ingall (D. H.), Relation between Mechanical Properties and Microstructure in Pure Rolled Zinc, 198
Iokibe (K.), and S. Sakai, The Effect of Temperature on the Rigidity and Viscosity of Metals, 97
Irwin-Smith (Vera), Australian Diptera Brachycera. Part I: Stratiomyiidæ, No. 3, 591

Jackson (J.), Stellar Parallax, 124
Jameson (Dr. H. Lyster), Japanese Culture Pearls, 528; The "Proletarisation of Science" in Russia, 147
Jeans (J. H.), appointed Halley Lecturer for 1922, 134
Jeffery (F. H.), The Electrolysis of Aqueous Solutions of Alkaline Nitrates with a Lead Anode, etc., 516
Jeffery (J. A.), Text-book of Land Drainage, 7
Jeffreys (Dr. H.), Artificial Production of Rain, 313; Relativity and Materialism, 568; The Age of the Earth, 284, 370; The Dynamics of Wind, 453; Uniform Motion in the Æther, 80
Jenkins (Dr. J. T.), A Text-book of Oceanography, 38
Jenness (D.), The Copper Eskimo of Coronation Gulf, 478
Johnson (Dr. F.), Experiments in the Working and Annealing of Copper, 198
Johnson (N. K.), The Behaviour of Pilot Balloons at Great Heights, 453
Johnson (Dr. S. C. and W. B.), Freshwater Fishes and How to Identify Them, 79
Johnson (Rev. W. F.), The Irish Ichneumonidæ and Braconidæ, 224
Johnston (Sir H. H.), Emin Pasha's Last Collections, 397
Johnstone (J.), The Limitations of the Knowledge of Nature, 554
Jones (Prof. B. M.), Experimental Work on Mapping from the Air, 544
Jones (F. Morton), The Influence of Insect-trapping Plants on their Insect Associates, 253
Jones (L. R.), North England: An Economic Geography, 495
Jones (W. Neilson), The Occurrence of Brachiomonas, 516
Jonesco (S.), Anthocyanidines in the Free State in the Flowers and Red Leaves of some Plants, 135; The Formation of Anthocyanine in the Flowers of *Cobaea scandens* at the Expense of the pre-existing Glucosides, 422
Jordan (W. L.), The Disaster to the Airship R 38, 114
Jourdain (Rev. F. C. R.), Depredations of Egg-collectors in Spitsbergen, 67; The Oxford Expedition to Spitsbergen, 1921. Ornithological Observations, 151
Judge (A. S.), Production of Tea in the Empire and its Relation to the Tea Trade of the World, 482

Kapteyn (Prof. J. C.), First Attempt at a Theory of the Structure and Motion of the Stellar System, 449
Kasner (Prof. E.), Relativity: Particles Starting with the Velocity of Light, 434
Kay (Dr. S. A.), A Text-book of Qualitative Analysis of Inorganic Substances, 527
Kaye (G. R.), Medieval Astronomical Instruments in India, 384
Keen (B. A.), awarded a Travelling Fellowship by the Ministry of Agriculture, 25; Climatic Factors in Agriculture, 300
Keith (Sir Arthur), and others, The Origin of the Scottish People, 548
Kennedy (Sir John), [obituary], 442
Kerr (Prof. J. Graham), Zoology for Medical Students, 493
Kidd (F.), C. West, and G. E. Briggs, A Quantitative Analysis of the Growth of *Helianthus annuus*, Part 1, 388
Kidd (Dr. W.), Biological Terminology, 11
Kimmins (Dr. C. W.), and others, Psychological Tests for Vocational Guidance, 322

Kling (A.), and A. Lassieur, The Separation and Estimation of Copper, Lead, Antimony, and Tin, 516
Klingender (L. H. W.), The Organised Co-operation of Museums in Germany, 289
Kober (Prof. L.), Der Bau der Erde, 236
Kopaczewski (W.), Surface Tension and the Suppression of Shock by Sodium Hyposulphite, 103
Korenchevsky (Prof. V.), Scientific Workers in Russia, 469
Kozlowski (A.), The Formation of the Red Pigment of *Beta vulgaris* by Oxidation of the Chromogens, 422; The Origin of the Oleoleucites in the Liverworts carrying Leaves, 199
Kozu (S.), and others, The X-ray Analysis of Andularia Felspar and Moonstone, 352
Kufferath (H.), The Stereogrammatic Interpretation of the Sporulation Curve of Yeasts, described by Hansen, 230
Kunhardt (Major J. C. G.), and Assistant Surgeon G. D. Chitre, Possibilities of Eradicating Plague by Rat Reduction, 587

Ladd (Prof. G. T.), [obituary article], 23
Laidlaw (Dr. F. F.), Two Entomological Discoveries in India, 129
Lamb (Prof. H.), elected an Honorary Member of the Manchester Literary and Philosophical Society, 477
Lambert (Prof. C. J.), [obituary], 413
Lambert (W. D.), The Rotation of the Earth, 192; The Tendency of Elongated Bodies to set in the East and West Direction, 528
Lang (Dr. W. D.), Catalogue of the Fossil Bryozoa (Polyzoa) in the Department of Geology, British Museum (Natural History). The Cretaceous Bryozoa (Polyzoa). Vol. 3. The Cribrimorphs. Part 1, 39
Langevin (Prof. P.), elected an Honorary Member of the Royal Institution, 477; The Theory of Relativity and the Experiment of M. Sagnac, 422
Langmuir (Dr. I.), Molecular Structure, 325; Types of Valence, 101; and others, The Constitution of Molecules, 218
Lapworth (Prof. A.), Valency Bonds and the Mechanism of Organic Reactions, 584
Larmor (Sir Joseph), awarded the Copley Medal of the Royal Society, 380; Escapements and Quanta, 254
Lassieur (M. and Mme. A.), The Rapid Electro-analysis of Brass, 389
La Touche (Sir James D.), [obituary], 221
Lea (A. M.), New Species of Australian Coleoptera. Part xvii., 518
Le Bas (G.), A Relation between the Combined Atomic Volumes and their Optical Refractivities, 272
Lebour (Dr. Marie), The Food of Baby Fish, 585
Lecat (M.), Bibliographie des Séries Trigonométriques: Avec un Appendice sur le Calcul des Variations, 112
Lees (C. H.), The Thermal Stresses in Spherical Shells concentrically heated, 421
Lees (Lt.-Col. E. F. W.), Aeronautical Maps, 165
Lefebure (Major V.), The Riddle of the Rhine: Chemical Strategy in Peace and War, 331
Legendre (J.), Anophelism and Rabbit-breeding, 294
Leigh (H. S.), appointed to an Honorary Research Fellowship in the University of Manchester, 553
Leitch (Miss I.), Breeding Experiments with the Princess Beans of Prof. Johannsen, 578
Lemay (P.), and L'Jaloustre, The Oxidising Properties of certain Radio-active Elements, 454
Lémonon (H.), Utilisons la Houille Bleue, 445
Lémonon (M.), Tidal Power, 546
Le Morvan (C.), Photographic and Systematic Map of the Moon, 325
Lennox-Conyngham (Col. Sir Gerald), elected Prælector of Geodesy at Trinity College, Cambridge, 229
Lepierre (C.), A New Type of Mineral Water: Nitrate Waters, 389
Lévine (J.), Atlas Météorologique de Paris, 6
Levy (Prof. H.), The Function of the Scientist in Organised Research, 161
Lewis (F. G. H.), An Automatic Voltage Regulator, 388
Lewis (H. P.), appointed Assistant Lecturer in Geology in Sheffield University, 262
Lewis (Prof. W. C. McC.), Radiation and Chemical Action, 241
Lewis's, Ltd., Gift for Scholarships at Manchester University, 386
Leyton (Dr. A. S. F.), [obituary article], 284
Lieske (Prof. R.), Morphologie und Biologie der Strahlenpilze (Actinomyceten), 397
Ligertwood (Miss L. M.), appointed Lecturer in Physiology in Birmingham University, 195
Lindley (Lord), [death], 506; [obituary article], 541
Ling (A. R.), and D. R. Nanji, The Longevity of Certain Species of Yeast, 388
Lipka (J.), Motion on a Surface for any Positional Field of Force, 326
Lishman (W. E.), The Flight of Thistledown, 340
Lister (Sir F. Spencer), presented with the South Africa Medal and Grant, 551
Liveing (Dr. G. D.), presentation of an Address to, by Cambridge University, 354
Lloyd (Dorothy J.), and C. Mayes, The Titration Curve of Gelatine, 485
Lock (Rev. J. B.), [death], 94
Lockyer (Major W. J. S.), Auroral Display of September 28–29, 180, 370; Next Year's Total Solar Eclipse (September 21, 1922), 570; and D. L. Edwards, The Spectrum of ϕ Cassiopeiæ, 256
Lockyer (the late Sir Norman), the Memorial Medallion of, 25
Lodge (Sir Oliver), Cosmic Friction: A Query, 275; Einstein's Real Achievement, 98; Speech through the Æther, 88; The Action of Sunlight, 496; The Æther of Space, 223; The "Philosophical Magazine," 12
Loisel (P.), The Existence of a New Radio-active Emanation in the Springs of Bagnoles-de-l'Orne and its Neighbourhood, 454, 517
Long (Dr. Constance E.), Collected Papers on the Psychology of Phantasy, 525
Loram (Dr. C. T.), The Native Problem, 551
Loth (W.), Solution of the Problem of the Direction of Aeroplanes and Dirigibles in Mist or on Dark Nights, 554
Lotsy (Prof. J. P.), Hybridity and the Evolution of Species, 274, 400
Louis (Prof. H.), The Mineral Industry of India, 343
Loveday (Prof. T.), appointed Vice-Chancellor of Bristol University, 419
Lowndes (A. G.), Methods of Improving Visibility, 337
Luciani (Prof. L.), Human Physiology (in 5 vols.) Vol. 5. Metabolism—Temperature—Reproduction, etc. Edited by Prof. M. S. Pembrey, 204
Lumb (A. D.), The Platinum Metals, 268
Lumière (A.), and H. Couturier, Sodium Oleate in the Phenomena of Shock, 230; The Desensibilisation of Anaphylactised Animals by Means of Several Antigens, 389; The Relations between the Anaphylactic Shock and the Introduction of Precipitates into the Circulation, 135
Lunt (Dr. J.), Stellar Distances, Magnitudes, and Movements, 551
Luyten (W. J.), Observations of Variable Stars, 291
Lyons (Col. H. G.), awarded the Symons Memorial Gold Medal of the Royal Meteorological Society, 414; Orientation in Egypt, 587

MacBride (Prof. E. W.), Echinoderm Larvæ and their Bearing on Classification, 529
MacCulloch (Canon J. A.), The Attitude of 16th and 17th Century Folk-lore to Fairies and Witches, 583
Macdonald (Dr. A.), Meteorology in Medicine, with special reference to the Occurrences of Malaria in Scotland, 135
MacDowall (A. B.), Sun-spots and Weather, 68
Macdowell (E. C.), and E. M. Vicari, Influence of Alcoholic Grandparents upon the Behaviour of White Rats, 67

Macfadyen (Prof. W. A.), Observations and Proposals for the Stabilisation of Money Values, 552
MacKenzie (Dr. D.), Scottish Folk-lore, 583
Mackenzie (Sir Leslie), Speech in the Silent World, 191
MacMahon (P. A. and W. P. D.), The Design of Repeating Patterns, 421
MacMunn (N.), The Child's Path to Freedom, 79
Macready (Lieut. J.), A New Height Record by Biplane, 190
Magnus (Sir Philip), impending retirement from Parliament, 420
Maiden (J. H.), Records of Australian Botanists, 357
Mailhe (A.), Petrol prepared from Rape Oil, 326
Mallock (A.), Metallic Coloration of Chrysalids, 302; Metallic Colouring of Beetles, 432; Propagation of Waves in an Isotropic Solid, 465; Ruling Test Plates for Microscopic Objectives: Sharpness of Artificial and Natural Points, 10
Mallory (Mr.), The Mount Everest Expedition, 577
Malvezin (P.), C. Rivalland, and L. Grandchamp, A New Preparation of Formaldehyde Hydrosulphite and an Economical Generator of Hydrosulphurous Acid, 555
Mann (C. W.), Preliminary Note on the Occurrence of Porphyritic Intrusions at Yass, N.S.W., 518
Mann (Prof. G.), [obituary], 221
Manning (Prof. W. A.), Stanford University Publications, University Series: Mathematics and Astronomy. Vol. 1, No. 1: Primitive Groups, Part 1, 39
Maquenne (L.), and E. Demoussy, The Respiration of Leaves in a Vacuum or in Atmospheres poor in Oxygen, 32
Marsden (E.), and T. A. Smith, Geography for Junior Classes, 527
Martin (L. C.), The Physical Meaning of Spherical Aberration, 589
Martin (M. J.), The Electrical Transmission of Photographs, 334
Marvin (Dr. C. F.), The Law of the Geoidal Slope and Fallacies in Dynamic Meteorology, 545
Mascart (J.), Calendar Dates in Meteorology, 28
Mason-Thompson (E. R.), The "Prizma" Process of Colour Cinematography, 225
Massingham (H. J.), Some Birds of the Countryside: The Art of Nature, 142
Masson (I.), N. F. Gilbert, and H. Buckley, A Suggested Method of Investigating the Viscosity of Glass, 590
Mathews (E. B.), and H. P. Little, The Position of Geology and Geography in the United States, 225
Mathews (G. M.), and T. Iredale, A Manual of the Birds of Australia. Vol. 1.: Orders Casuarii to Columbae, 299
Matthai (G.), General Account of a Marine Biological Excursion to Karachi during December, 1920, and January, 1921, 591
Matthews (Rev. Prof. W. R.), Studies in Christian Philosophy, being the Boyle Lectures, 1920, 559
Maxwell (Sir Herbert), *Ophion luteus*, 339, 436
May (W. L.), New Species of Fossil Mollusca, 72
McAdie (Dr. A.), Remarkable July Rainfall at Blue Hill, Mass., 12
McClure (Rev. Canon E.), Relativity and Materialism, 467
McIlwraith (T. F.), African Death Rites, 583; Egyptian Influence on African Death Rites, 163, 418
McIntosh (Prof. W. C.), Scottish Fisheries, 228
McKay (J. W.), The Tea Industry, 483
McLennan (Prof. J. C.), Radiation and Absorption by Atoms with Modified Systems of Extra-nuclear Electrons, 448
Mead (A. D.), The Most Economical Height of a Dam, etc., 445
Mears (F. C.), The Medieval Period of Edinburgh, 165
Meesters (P.), The August Meteoric Display, 69
Meldrum (Dr. A. N.), and D. M. Gangoli, Indian Casein, 317
Mellor (Miss Ethel), The Lichens which attack Glass and their Mechanical Action on Stained Glass Windows of Churches, 517
Mellor (Dr. J. W.), Communism and Science, 113
Meltzer (S. J.), Are the superior Cervical Ganglia indispensable to the Maintenance of Life?, 294
Melville (H.), with an Introduction by V. Meynell, Moby-Dick or the Whale, 39
Melville (Dr. J. C.), The Sidebotham Collection of Lepidoptera in the Manchester Museum, 478
Menzies (Prof. A. W. C.), Tin Plague and Scott's Antarctic Expedition, 496
Mercer (H. N.), appointed Assistant Lecturer in Physics in the Faculty of Technology of Manchester University, 262
Mercier (M.), The Measurement of the Velocity of Propagation of Electric Waves along Metallic Wires, 389
Merrill (G. P.), Chondrules and Chondritic Structure in Meteorites, 263
Merrill (P.), Nebular Lines in Spectrum of R Aquarii, 98
Merton (Prof. T. R.), The Spectra of Lead Isotopes, 356
Mesurier (L. J. le), The Maag Gearing, 479
Michaud (F.), The Surface Tension of Electrified Liquids, 486
Michell (Miss M. R.), The Effect of Fire on the Vegetation of Signal Hill, 518
Michelson (Prof. A. A.), The Vertical Interferometer; The Application of Interference Methods to Astronomical Measurements, 263
Michkovitch (M.), The Planet (7) Iris, 69
Micklethwait (Dr. Frances M. G.), resignation of the Principalship of Swanley Horticultural College, 229
Migeod (F. W. H.), The Ceremonial Avoidance of Contact with the Ground, 583
Mill (Dr. H. R.), The Shackleton-Rowett Oceanographic and Antarctic Expedition, 159
Mitchell (Dr. A. Crichton), The Diurnal Variation of Atmospheric Pressure at Castle O'er and Eskdalemuir Observatory, 135
Mockler (G. S.), appointed Lecturer in Geology in the University of Durham, 71
Moir (J.), Colour and Chemical Constitution, Part 15, 422; Part 16, 518
Moir (Dr. J.), The Atomic Theory of 1921, 551
Montelius (Dr. O.), [obituary article], 379
Moore (Prof. B.), Photosynthetic Processes in the Air, upon the Land, and in the Sea, etc., 383
Morgan (Prof. C. Lloyd), Consciousness and the Unconscious, 213; Mind and Consciousness, 60; presented with his portrait, 514
Morison (J. M. W.), appointed Lecturer in Applied Anatomy in the University of Manchester, 553
Morris (C. R.), appointed to a Lectureship in Philosophy at Balliol College, 262
Morrison (F. R.), The Occurrence of Rutin in the Leaves of the Boronia (N. O. Rutaceæ), 591
Mortensen (Dr. Th.), Studies of the Development and Larval Forms of Echinoderms, 459
Morton (Mr.), bequest to Birmingham University, 102
Moseley (H. G. J.), unveiling of a Memorial to the late, 483
Munby (A. E.), Laboratories: Their Planning and Fittings, 140
Munn (Major L.), The Ancient Mines and Megaliths in the Hyderabad State, 96
Murphy (P. A.), The Bionomics of the Conidia of *Phytophthora infestans*, 590; The Presence of Perennial Mycelium in *Peronospora Schleideni*, Unger, 304
Murphy (R. C.), Expedition to the Peruvian Littoral, 544

Němec (A.), and F. Duchoň, The Possibility of determining the Value of Seeds by the Biochemical Method, 454
Nernst (Prof. W.), awarded the Nobel Prize for Chemistry for 1920, 380
Neuburger (Dr. M. L.), The Isotopy of the Radio-elements, 180
Newbigin (Dr. Marion), The Mediterranean City-state in Dalmatia, 165
Newland (B.), [obituary], 189
Newnham (E. V.), Long-range Weather Forecasts, 579
Newton (E. T.), elected President of the Palæontographical Society, 576

Nicholls (H. W.), and W. R. Andrew, awarded Post-graduate Research Scholarships in Naval Architecture by the Institution of Naval Architects, 166
Nichols (Dr. E. F.), resignation of the Presidency of the Massachusetts Institute of Technology, 507
Nicholson (Dr. J. W.), A Problem in the Theory of Heat Conduction, 421; elected to a War Memorial Fellowship at Balliol College, 262
Noble (G. K.), Aggressive Warning Attitude assumed by Snakes when disturbed, 27
Noble (Sir William J.), elected President of the North-east Coast Institution of Engineers and Shipbuilders, 317
Noel (Capt. J. B. L.), The Photographic Equipment and Methods of Work for Travellers, 579
Noguchi (Y.), Hiroshige, 301
Nolan (J. J.), Ionisation in Moist and Dry Air, 554
Nordmann (C.), Intrinsic Brightness and the Effective "Diameters" of Stars, 294
Norman (Major G. H.), [obituary], 94
Noteboom (E.), The Perturbations of Eros, 256

Obaton (F.), The Comparative Structure of Leaves of the Same Age and Different Dimensions, 517
O'Brien (Lt.-Col. A.), Canals of the Punjab, 478
Oertling (H. R. A.), [obituary], 575
Oliver (Dr. T. H.), appointed Lecturer in Clinical Medicine in the University of Manchester, 553
Omori (Prof.), Seismometric Measurements of Columns in Japan, 130
Onslow (Hon. H.), Metallic Coloration of Chrysalids, 366
Orla-Jensen (Prof.), translated by P. S. Arup, Dairy Bacteriology, 431
Orton (Dr. J. H.), An Oyster Spat (1921) with Mature Male Sexual Products, 500; Is Bisexuality in Animals a Function of Motion ?, 145; Sex-manifestations and Motion in Molluscs, 303
Orwin (C. S.), The Study of Agricultural Economics (Presidential Address to the Agriculture Section of the British Association), 61, 501
Osborne (G. D.), A Preliminary Examination of the late Palæozoic Folding in the Hunter River District, N.S.W., 199; and W. R. Browne, A Glaciated Striated Pavement in the Kuttung Series of the Maitland District, 103
Osgood (W. H.), The Affinities of Cænolestes, 67
Osler (William), Counsels and Ideals: From the Writings of, Second Edition, 430
Owens (Dr. J. S.), An Automatic Recorder of Smoke Pollution, 166

P. (W. M. F.), The Use of the Classics, 180
Pacheco (E. H.), Photographs of Gigantic Turtles in an Upper Miocene Flood-deposit in the Otero de Palencia, 482
Painlevé (P.), Classical Mechanics and the Theory of Relativity, 357
Palmer (A. H.), Climatology in California, 68
Palmer (R. W.), appointed Senior Lecturer in Geology in Manchester University, 386
Pandé (S. K.), A Ruston *Euphorbia tibetica*, 591
Pannell (J. R.), [obituary article], 127
Partington (Prof. J. R.), The Constitution of Molecules, 242
Pascal (P.), Magnetochemical Research on Constitution in Mineral Chemistry, 357
Passemard (E.), The Alluvial Terraces of Sebou above Fez, 230
Passmore (Dr. F. W.), [obituary article], 379
Pasteur (L.), the forthcoming Centenary of the Birth of, 25
Patchin (G.), The Micro-examination of Metals, with special reference to Silver, Gold, and the Platinum Metals, 453
Patton (Major), The Bed-bug the Host of the Parasite of Kala-azar, 443
Paynter (J. E.), Practical Geometry for Builders and Architects, 564
Pear (Prof. T. H.), The Visualisation of Numbers in Space, 325
Pearce (Dr. E. C.), elected Vice-Chancellor of Cambridge University, 195
Pearl (Prof. R.), The Transitory Effect of War upon the Rate of Growth of Population, 443
Pearson (Prof. K.), and Miss A. G. Davin, The Sesamoids of the Knee-joint in Man, 70
Pearson (Mrs. L.), appointed to an Honorary Research Fellowship in the University of Manchester, 553
Pease (F. G.) and others, Antares and its Companion, 193
Pendred (L.), Speaking Films, 338
Penfold (A. R.), Position of the Double Linkage in Piperitone, 199; The Essential Oil of *Leptospermum flavescens* (Smith), 518; and M. B. Welch, Two Pinnate-leaf Boronias and their Essential Oils, with description of a new species, 591
Perrett (Dr. W.), The Resonance Theory of Hearing, 569
Perry (W. J.), Institution and Behaviour in Fijian Society, 139
Perucca (E.), The Volta Effect in a Vacuum and in Highly Rarefied Gases, 263
Petch (T.), The Diseases and Pests of the Rubber Tree, 524
Peters (Dr. R. A.), appointed a University Lecturer in Bio-chemistry in Cambridge University, 292
Petrie (J. M.), The Active Principle of *Erythrophloeum Laboucherii*, 231
Pettersson (Dr. H.), Internal Movements in the Sea, 450
Peyronel (Dr. B.), *Menispora microspora*, n. sp., one of the Hyphomycetæ with mesoendogenous conidia, 390
Philippson (M.), The Laws of the Electrical Resistance of Living Tissues, 231
Picken (D. K.), The Euclidean Geometry of Angle, 486
Pijper (C.), and H. Zwarenstein, The "Account Book" of Jan Haszing, 518
Pippard (A. J. S.), and Capt. J. L. Pritchard, with an Introduction by L. Bairstow, Aeroplane Structures, 36
Planck (Prof. Max), Vorlesungen über die Theorie der Wärmestrahlung, Vierte Auflage, 527
Plaskett (H. H.), The Pickering Series in O Type Stars, 209
Plimmer (Dr. R. H. A.), appointed Professor of Chemistry at St. Thomas's Hospital Medical School, 552
Plimpton (S. J.), The Softening of Secondary X-rays, 402
Pocock (R. I.), Otters, 163
Ponder (A. O.), appointed to a Lectureship in Chemistry at Balliol College, 262
Ponder (E.), The Hæmolytic Action of Sodium Glycocholate, 485
Pope (Sir William J.), conferment upon, of the Degree of Doctor of Laws by McGill University, 71; conferment upon, of the Honorary Degree of D.Sc. by Calcutta University, 553; elected an Honorary Fellow of the Canadian Institute of Chemistry, 127; presented with the Dumas Medal of the Société de Chimie industrielle, and with an address, 251
Popenoe (W.), Manual of Tropical and Sub-tropical Fruits: excluding the Banana, Coconut, Pineapple, Citrus Fruits, Olive and Fig, 334
Porter (Prof. A. W.), elected President of the Faraday Society, 544
Potter (Prof. M. C.), An Electromotive Force developed by the Fermentation of Cane-sugar, 446
Potts (F. A.), The Work of the Carnegie Institution in the Marine Biology of Samoa, 590
Praeger (R. Lloyd), The Genus Sedum as found in Cultivation, 578
Prain (D.), appointed Senior District Agricultural Officer in Tanganyika Territory, 190
Priest (W. B.), Awards to Discoverers, 498
Priestley (J. H.), The Resistance of the Normal and Injured Plant-surface to the Entry of Pathogenic Organisms, 589
Pring (J. N.), and E. O. Ransome, Reaction between Cathodic Hydrogen and Nitrogen at High Pressures, 515
Procopiu (S.), The Depolarisation of Light by Liquids holding Crystalline Particles in Suspension, 135

Pryce (F. N.), A Remarkable Minoan Bronze Statuette in the British Museum, 95
Pye-Smith (D. E.), admitted a Partner of Bowes and Bowes, 511

Quayle (E. T.), Anticipated Benefits from Irrigation in Victoria and New South Wales, 27; Local Rain-producing Influences in South Australia, 517

Ramamurty (S. V.), Relativity and Materialism, 569
Raman (Prof. C. V.), A Method of Improving Visibility of Distant Objects, 242; conferment upon, of the Honorary Degree of D.Sc. by Calcutta University, 553; Smoky Quartz, 81; The Colour of the Sea, 367; The Molecular Scattering of Light in Liquids and Solids, 402; The Phenomenon of the Radiant Spectrum observed by Sir David Brewster, 485; The "Radiant" Spectrum, 12; and B. Ray, The Transmission Colours of Sulphur Suspensions, 356; and G. A. Sutherland, The Whispering Gallery Phenomenon, 42, 421
Ramsay (the late Sir William), the new Chemistry Laboratories at University College, London, to be named after, 419
Rankine (Prof. A. O.), Speaking Films, 276, 339; The Structure of Some Gaseous Molecules of which Hydrogen is a Constituent, 590
Rao (P. R.), Activities of the Indian Board of Scientific Advice, 254
Rasmussen (K.), Ethnological Expedition to the Canadian Arctic Archipelago, 189; Progress of his Expedition, 442
Rateau (A.), A New Locking Screw Nut, 263
Rathgen (Dr. F.), Chemical Examination of a Babylonian Glass Vase, 580
Rayleigh (Lord), Occurrence of the Aurora Line in the Spectrum of the Night Sky, 208; The Age of the Earth, 279, 335; and others, The Age of the Earth, 217
Raymond (Prof. P. E.), Fauna of the Trenton Group, 481; The Appendages, Anatomy, and Relationships of Trilobites, 481
Rayne (Major H.), Sun, Sand, and Somals: Leaves from the Notebook of a District Commissioner in British Somaliland, 112
Read (Prof. A. A.), and R. H. Greaves, The Properties of Some Nickel–Aluminium–Copper Alloys, 197
Reboul (G.), A New Radiation of Short Wave-lengths, 555
Reeves (E. A.), The Tendency of Elongated Bodies to set in the North and South Direction, 433
Reid (Sir G. Archdall), Biological Terminology, 176, 401; Inheritance, Mendelism, and Mutation, 335
Rew (Sir R. Henry), The Progress of Agriculture, 415
Reynolds (Prof. S. H.), A Geological Excursion Handbook for the Bristol District, Second edition, 10
Rhodes (E. C.), Smoothing (Tracts for Computers, No. 6), 495
Richard (P. and M.), The General Problem of Aviation, 389
Richards (E. Windsor), [obituary], 379
Richards (F. S.), The Age of the Great Temple of Ammon at Karnak as determined by the Orientation of its Axis, 587
Richards (Prof. J. W.), [obituary], 286
Richardson (L. F.), The Flight of Thistledown, 340
Richardson (Prof. O. W.), Problems of Physics (Presidential Address to the Mathematics and Physics Section of the British Association), 56, 372
Richmond (H. W.), elected President of the London Mathematical Society, 414
Rideal (Dr. E. K.), Chemical Reactivity and the Quantum Theory, 259
Ridewood (Dr. W. G.), [obituary article], 160
Ridgeway (Sir W.), Totemism and the Theory of Ancestral Worship, 129; and others, Totemism, 583
Ris (Dr. F.), The Dragon-flies of South Africa, 224
Ritchie (Dr. J.), Status of the Walrus as a Member of the British Fauna, 27
Rivers (Dr. W. H. R.), The Melanesian System of Land-tenure, 354, 583; The Origin of Hypergamy, 224
Roberts (S. C.), A History of the Cambridge University Press, 1521–1921, 365
Robotham (J. A.), appointed Assistant Agricultural Superintendent, St. Kitts-Nevis, 190
Robson (G. C.), Is Bisexuality in Animals a Function of Motion ?, 212; Sex-manifestation and Motion in Molluscs, 403
Rockefeller (J. D.), provision of Funds for the Purchase of the Birthplace of Pasteur, 576
Rodenhauser (W.), J. Schoenawa, and C. H. Vom Baur, Electric Furnaces in the Iron and Steel Industry. Translated by C. H. Vom Baur. Third edition, 562
Roe (J. P.), [death], 127
Rogers (Dr. A. W.), elected President of the South African Association, 552
Rogers (H.), The History of Rubber Manufacture, 349
Rogers (R. A. P.), The Simplest Mode of Representing a Continuous Linear Orthogonal Transformation, etc., 554
Rohr (Prof. M. von), Die Binokularen Instrumente: Nach Quellen und bis zum Ausgang von 1910 Bearbeitet. Zweite Auflage, 109
Rolfe (R. T.), The Effect of Increasing Proportions of Lead upon the Properties of Admiralty Gun-metal, 197
Rosa (Prof. E. B.), The Economic Importance of the Scientific Work of the [U.S.] Government; Scientific and Engineering Work of the [U.S.] Government, 29
Roscoe (Rev. J.), The Mackie Ethnological Expedition to Uganda, 583
Rothé (E.), The Use of Radiogoniometry in the Study of Storms and of Atmospheric "Parasite" Currents, 422
Roubaud (E.), Fertility and Longevity of the Domestic Fly, 517
Roux (F.), H. Vallée, H. Carré, and the late M. Nocard, *Résumé* of Experiments on Aphthous Fever, 554
Rowan (W.), The Breeding Haunts and Habits of the Merlin, 478
Rowe (Lt.-Col. R. H.), Annual Report, for 1920, of the Gold Coast Survey Dept., 96
Rumbold (W. G.), Chromium Ore, 268
Russell (Dr. E. J.), Science and Crop Production (Farmers' Lecture of the British Association), 116; Soil and Soil Management, 7; and Miss Mary S. Aslin, A Catalogue of Journals and Periodicals in the Library of the Rothamsted Experimental Station, 444
Russell (E. W.), Muscular Piezo-electricity ?, 275
Rutherford (Sir Ernest), elected an Honorary Member of the Manchester Literary and Philosophical Society, 477

Safarik (Prof. V.), Variable Stars, 131
Saha (Dr. M. N.), Ionisation in Stellar Atmospheres, 131; Rubidium in the Sun, 291
Sahni (Dr. B.), Preliminary Account of a Petrified Palm Stem (Palmoxylon sp.) from the Tertiary Rocks of Jammu, 591
Saleeby (Dr. C. W.), The Action of Sunlight: A Case for Inquiry, 466
Sanderson (E. D.), Insect Pests of Farm, Garden and Orchard. Second edition, by Prof. L. M. Peairs, 495
Sassa (K.), Effects of Constant Galvanic Currents upon the Mammalian Nerve-muscle and Reflex Preparations, 485; Reflex Responses to the Rhythmical Stimulation in the Frog, 485
Sazerac (R.), and C. Levaditi, The Action of Certain Bismuth Derivatives on Syphilis, 555
Scharff (J. W.), appointed Lecturer in Biology at King Edward VII. Medical School, Singapore, 386
Schenck (Prof. R.), Translated and Annotated by R. S. Dean, The Physical Chemistry of the Metals, 562
Schiller (Dr. F. C. S.), Novelty, 294
Schmidt (Dr. Johs.), The Danish Deep Sea Expedition, 186

Schnippenkötter (Dr. J.), Der Entropologische Gottesbeweis : Die physikalische Entwicklung des Entropieprinzips, seine philosophische und apologetische Bedeutung, 527
Schoep (A.), Curite, A New Radio-active Mineral, 555
Schuster (Sir Arthur), elected an Honorary Member of the Manchester Literary and Philosophical Society, 477 ; The Tendency of Elongated Bodies to set in the North and South Direction, 240
Schütte (K.), The Orbit of 887 Alinda, 256
Sclater (W. L.), The " Zoological Record," 436
Scott (Dr. D. H.), The Present Position of the Theory of Descent, in Relation to the Early History of Plants (Presidential Address to the Botany Section of the British Association), 60, 153
Scott (H. H.), and C. Lord, Studies in Tasmanian Mammals, *Zaglossus Harrissoni*, sp. nov., 72
Scripture (Prof. E. W.), The Nature of Vowel Sounds, 82
Searle (A. B.), The Clayworker's Handbook. Third edition, 398
Sedlák (F.), Pure Thought and the Riddle of the Universe. Vol. 1, Creation of Heaven and Earth, 9
Seely (Major-Gen. J. E. B.), acceptance of Office of President of the Thirty-third Congress of the Royal Sanitary Institute, 576
Seligman (Prof. C. G.), and others, Forthcoming Ethnographic Expedition to the Sudan, 450
Serville (R.), The Tangential and Radial Resistance of a Turning Body, 135
Sesamy, Life and Mind, 83
Seward (Prof. A. C.), elected President of the Cambridge Philosophical Society, 348 ; The Danish Arctic Station, 320
Shackleton (Sir Ernest), change of Plans for the Antarctic Expedition, 478
Shannon (W. G. St. John), A Composite Sill at Newton Abbot, 485
Shapley (Dr. H.), A New Suggestion to Explain Geological Climatic Changes, 417 ; appointed Director of the Harvard College Observatory, 443 ; and Miss B. W. Mayberry, The Furthest Cluster, 580 ; and Helen N. Davis, Studies of Magnitude in Star Clusters, XII., 263
Shaw (Sir Napier), London Air, 166
Shaxby (J. H.), Reflection " Halo " of (Semi-)Cylindrical Surfaces, 369
Sheals (A.), and C. B. Moffat, Squirrels Born Early in the Year, 163
Shephard (J.), The Rotifera of Australia and their Distribution, 517
Sheppard (T.), Spurn Point and the Lost Towns of the Humber Coast, 253
Sherrington (Prof. C. S.), elected President of the British Association, 95 ; elected President of the Royal Society, 476 ; The Maintenance of Scientific Research, 470
Shipley (Sir A. E.), Indian Land Mollusca, 271
Simons (Dr. L.), appointed Reader in Physics at Birkbeck College, 552
Singer (Dr. C.), The History of Anatomical Illustration, 141 ; The History of the Doctrine of Infection, 507
Skaife (S. H.), Variation and Heredity in the Bruchidæ, 295
Skues (G. E. M.), The Way of a Trout with a Fly, and Some Further Studies in Minor Tactics, 301
Sladen (F. W. L.), [death], 127
Sloog (H.), [death], 346
Small (Prof. J.), The Flight of Thistledown, 500
Smith (Eng.-Com. E. C.), Science in Westminster Abbey, 437 ; The Calendar of Scientific Pioneers, 567
Smith (Prof. E. F.), Priestley in America, 1794–1804, 394
Smith (Prof. G. Elliot), Bütschli's Lectures on Comparative Anatomy, 236 ; elected an Honorary Member of the Manchester Literary and Philosophical Society, 477 ; and Capt. G. Crowden, The Mound Builders of Dunstable, 512
Smith (J. Warren), Agricultural Meteorology : The Effect of Weather on Crops, 300
Smith (W. Campbell), Some Minerals from Leadhills, 388
Smithells (Prof. A.), From a Modern University : Some Aims and Aspirations of Science, 429
Smits (Prof. A.), Die Theorie der Allotropie, 298
Soergel (W.), Die Ursachen der diluvialen Aufschotterung und Erosion, 464
Sokoloff (Dr. B.), The " Proletarisation of Science " in Russia, 20
Sollas (Prof. W. J.), The Age of the Earth, 281
Somigliana (C.), Depth of Glaciers, II., 389 ; III., 390
Sôtome (K.), Studies on Astronomical Time-keepers and Time-preserving Systems, 175
Sousa (P. de), Some Remarkable Rocks from Angola, 389
Southborough (Lord), elected an Honorary Member of the Institution of Electrical Engineers, 413
Souza (D. H. de), and J. A. Hewitt, Idio-ventricular Periodicity, 485
Sparre (M. de), The Yield of Reaction Turbines working under a Variable Load, 516
Spencer (Sir Baldwin), Australian Ethnology, 191
Stamp (L. D.), The Base of the Devonian, with Special Reference to the Welsh Borderland, 453 ; and S. W. Wooldridge, The Igneous and Associated Rocks of Llanwrtyd (Brecon), 453
Stansfield (J.), Banded Precipitates of Vivianite in a Saskatchewan Fireclay, 589
Stebbing (Rev. T. R. R.), Curiosities of Nomenclature, 340
Stebbings (Dr. J.), to succeed Prof. G. C. Comstock as Director of the Observatory of the University of Wisconsin, 443
Steel (T.), Calcium Oxalate in the Gidgee Wattle (*Acacia Cambagei*), 103 ; Chemical Notes : Botanical, 591 ; Gold-coloured Teeth of Sheep, 242
Steele (L. J.), and H. Martin, A New Method of Automatic Electric Welding, 547
Stefansson (V.), arrival at Wrangell Island of the Expedition of, 414 ; Work of the Canadian Arctic Expedition of 1913–18, 349
Steiner (L.), A Special Form of Magnetic Disturbance, 446
Stelfox (A. W.), *Pisidium clessini* in British Lochs, 40 ; and C. B. Moffat, A Curious Flight by a Hairy-armed Bat, 163
Stenton (R.), *Ophion luteus*, 403
Stephenson (Dr. J.), Penial and Genital Setæ of *Lumbricus terrestris*, L., Müll., 337
Stevens (T.), Hydraulic Power Development, 443
Stirling (W. G.), Smuggling of Drugs in the Federated Malay States, 67
Storm (Prof. A. V.), and Dr. K. C. Davis, How to Teach Agriculture : A Book of Methods in this Subject, 334
Stott (V.), Note on Pipettes, 590
Struben (A. M. A.), Tidal Power, 564
Stuart (Mrs. L. A.), bequests by, 166
Sumner (Capt. P. H.), The Design and Stability of Streamline Kite Balloons, with Useful Tables, Aeronautical and Mechanical Formulae, 111
Sutherland (G. A.), Simple Sensitive Flames, 532
Swales (E. R.), Apple Canker : Two Centuries' Practice in its Control, 290
Swann (Prof. W. F. G.), The Influence of the Size of the Earth on Certain Changes in Terrestrial Magnetism, 130
Swift (M. P.), The Development of Optical Industries, 305
Swisher (W. S.), Religion and the New Psychology, 525
Synge (E. H.), Uniform Motion in the Æther, 80
Synge (J. L.), A System of Space-Time Co-ordinates, 275

Takahashi (Y.), Measuring the Separations of Iron Lines produced between Nickel Steel Electrodes by the Spark of an Induction Coil, 350
Tassy (E.), and P. Léris, Les Ressources du Travail Intellectuel en France, 270
Taylor (G. I.), Experiments with Rotating Fluids, 356
Taylor (J. K.), Chemistry of Kurrajong Seeds, 518
Taylor (J. W.), The Land and Freshwater Mollusca of the British Isles, No. 24, 578
Taylor (T. W. J.), Radiation and Chemical Action, 210
Taylor-Jones (Prof. E.), The Theory of the Induction Coil, 461
Teichman (E.), Travels of a Consular Officer in North-west China, 234

Tennant (Rev. Dr. F. R.), Christian Theism, 559
Terroine (E. F.), and H. Barthélémy, Composition of the Egg of the Brown Frog (*Rana fusca*) at the Egg-laying Period, 294
Thatcher (Dr. R. W.), The Chemistry of Plant Life, 364
Thomas (Dr. D. L.), and Lucy B. Thomas, Kentucky Superstitions, 207
Thomas (Dr. E. N. Miles), resignation of the Keepership of the Department of Botany of the National Museum of Wales, 442
Thomas (Sir Garrod), gift to the University College of Wales, Aberystwyth, 293
Thomas (P.), and G. Carpentier, A very Sensitive Reagent for Copper: the Kastle-Meyer Reagent, 516
Thomas (T.), Notes on Dynamics, with Examples and Experimental Work, 207
Thompson (Prof. P.), [death], 413; [obituary article], 441
Thomson (Dr. E.), appointed Temporary President of the Massachusetts Institute of Technology, 508
Thomson (G. P.), Anode Rays and the Determination of the Isotopes present in Lithium, 446
Thomson (J.), [obituary], 221
Thomson (Sir J. J.), Address at the Unveiling of the Rayleigh Memorial in Westminster Abbey, 472; Alternation of Intensity of Light in the Column of Gas in contact with the Positive Electrode, 546; elected President of the Institute of Physics, 287
Thorburn (A.), British Mammals (in two vols.). Vol. 2, 364
Thorpe (Sir T. E.), Chemical Warfare, 331; Priestley in America, 394; Some Aspects and Problems of Post-war Science, Pure and Applied (Presidential Address to the British Association), 44
Tilden (Sir William A.), The Resting-place of Robert Boyle, 176
Tildesley (Miss), The Burmese Skull, 70
Tilho (M.), The Franco-Anglo-Egyptian Frontier and the Line of the Watershed between the Basins of the Nile and Lake Tchad, 294
Tilley (C. E.), The Granite-Gneisses of Southern Eyre Peninsula, 129
Tillyard (Dr. R. J.), A New Genus and Species of May-fly (order Plectoptera) from Tasmania, belonging to the family Siphluridæ, 591; Mesozoic Insects of Queensland, No. 8, Hemiptera Homoptera (continued), 103; Two Fossil Insect Wings in the Collection of Mr. John Mitchell, from the Upper Permian of Newcastle, N.S.W., belonging to the order Hemiptera, 591
Toit (Dr. A. L. du), Land Connections between the other Continents and South Africa in the Past, 551
Toni (G. B. de), The Leaves torn from the E Manuscript of Leonardo da Vinci, preserved in the Library of the French Institute, 294
Travers (M.), A New Method for the Estimation of Fluorine at the Ordinary Temperature, 422; A New Method for the Estimation of Silica, 357
Trevor (T. G.), Science in the Service of the State, 253
Trewman (H. F.), and G. E. Condliffe, The Elements of Direct-current Electrical Engineering, 431
Tritton (F. S.), Use of the Scleroscope on Light Specimens of Metals, 198
Trotter (A. P.), Aeroplane Photography for Archæology, 275; The Elements of Illuminating Engineering, 365
Troup (Prof. R. S.), The Silviculture of Indian Trees, 3 vols., 3
Truffaut (G.), and M. Bezssonnof, The Variations of Energy of *Clostridium Pastorianum* as Nitrogen-fixing Organisms, 422
Tschermak (Prof.), The Sad Case of, 543
Tschirch (Prof. A.), Handbuch der Pharmakognosie. Band iii., 203
Tuck (Dr. W. B.), appointed Professor of Chemistry at Middlesex Hospital Medical School, 293
Tucker (S. H.), appointed Lecturer in Organic Chemistry in Glasgow University, 102
Tulloch (Dr. W. J.), appointed Professor of Bacteriology in St. Andrews University, 166
Turnbull (H. W.), appointed Regius Professor of Mathematics in St. Andrews University, 293
Turner (A. J.), The Utilisation of Bitterns, 317
Turner (Prof. H. H.), The Norman Lockyer Observatory, 148
Turnor (C.), The Land and its Problems, 301
Tutton (Dr. A. E. H.), The Structure of Adularia and Moonstone, 352
Twyman (F.), The Annealing of Glassware and Annealing without Pyrometers, 590
Tychonis Brahe Opera Omnia. Tomi Quinti Fasciculus Prior, 237

Unwin (R. B.), The Use of Aeroplane Photographs for Map Production, 350
Urbain (Prof. G.), The Energetic Bases of the Atomic Theory, 290

Vallot (J.), Measurement of the Influence of Heat and Light on the Activity of Reduction by Animal Tissues and Applications to Heliotherapy, 555
Vaughan (T. W.), The Reef-coral Fauna of Carrizo Creek, California, 481
Vegard (L.), and O. Krogness, The Position in Space of the Aurora Polaris, from Observations made at the Haldde Observatory, 1913–14, 431.
Villedieu (M. and Mme. G.), The Toxicity of Metals for Yeasts and Moulds, 389
Visser (Dr. S. W.), The Green Colouring of Surf on the Horizon, 178
Vredenburg (E.), The Cypræidæ, 481; and B. Prashad, Fossil Unionidæ in the Indian Region, 481

Wagner (Dr. P. A.), The Mutue Fides-Stavoren Tinfields, 192
Walker (A. R. E.), A Specimen of *Phacops africanus*, Lake, 518
Walker (Dr. G. T.), The Rainfall in India of June and July and the Probable Amount during August and September, 130
Walker (G. W.), [death], 94; [obituary article], 188
Walker (Prof. Miles), The Flight of Thistledown, 242
Walkom (A. B.), A Specimen of Nœggerathiopsis from the Lower Coal Measures of New South Wales, 517
Wall (Dr. T. F.), Electrical Engineering, 205
Wallis (A. H.), The Rainfall of Southern Rhodesia, 509
Warburton (C.), re-appointed Demonstrator in Medical Entomology in Cambridge University, 261
Watson (G. W.), Industrial Standardisation, 318
Watson (Dr. R. W. Seton), The Successors of Austria-Hungary: Some of their Problems, 443
Watts (F.), An Introduction to the Psychological Problems of Industry, 74
Watts (Prof. W. W.), World List of Scientific Periodicals, 531
Webb (A. E.), appointed Senior Assistant in the Department of Civil and Mechanical Engineering at University College, London, 166
Webb (Dr. R. A.), appointed Demonstrator in Pathology in Manchester University, 262
Webster (A. D.), London Trees, 142
Webster (Prof. D. L.), and L. Page, The Present Status of the Atomic Structure Problem, 546
Wechsler (A.), A Simple Micro-barograph, 469
Weidlein (E. R.), appointed Director of the Mellon Institute of Industrial Research, 419
Weir (W. W.), Productive Soils: The Fundamentals of Successful Soil Management and Profitable Crop Production, 7
Weiss (Prof. F. E.), appointed Pro-Vice-Chancellor of Manchester University, 323
Whipple (F. J. W.), The Distribution of Brightness in the Penumbra during an Eclipse of the Moon, 497
Whitaker (J. I. S.), Motya: A Phoenician Colony in Sicily, 269
Whitaker (J. W.), Mining Physics and Chemistry, 564
Whitby (Dr. G. S.), Plantation Rubber and the Testing of Rubber, 35

White (C. T.), The Genus Flindersia (fam. Rutaceæ), 517
White (F. P.), The Diffraction of Plane Electromagnetic Waves by a perfectly Reflecting Sphere, 421
Whitehead (R. F.), An Algebraical Identity, 212
Whittaker (E. T.), Tubes of Electromagnetic Force, 486
Williams (E. C.), appointed Research Chemist to the Joint Benzole Research Committee, 419
Williams (J. W.), The Finding of *Bacillaria paradoxa*, 163
Williams (W. E.), and B. L. Worsnop, Absorption of X-rays, 306
Williamson (J. W.), Scientific Research in the United States, 29
Willis (B.), A Method of Tracing the Course of a Great Earthquake-rift by Photography from an Aeroplane, 416
Wilmott (A. J.), Experimental Researches on Vegetable Assimilation and Respiration, XIV., 388
Wilson (D. R.), Work of the Industrial Fatigue Research Board, 414
Wilson (G. V.), and Dr. J. S. Flett, Vol. 17 of the Special Reports on the Mineral Resources of Great Britain, 96
Wilson (H. W.), Co-operative Indexing of Periodical Literature, 43
Wilson (Sir James), The World's Wheat, 133
Wilson (Prof. W. H.), The Nutrition Values of Rations, 508
Wilson-Barker (Sir David), Methods of Improving Visibility, 337
Winterbotham (Lt.-Col. H. S.), The Present Position of the 1 : 1,000,000 Map, 165
Wolf (Dr. A.), the title of Professor of Logic and Scientific Method in the University of London conferred upon, 451
Wolf (Prof. M.), Names of Minor Planets, 69
Wollaston (A. F. R.), Life of Alfred Newton, Professor of Comparative Anatomy, Cambridge University, 1866–1907, 333
Wood (Prof. R. W.), The Spectra of Hydrogen from Long Vacuum Tubes, 449; The Time Interval between the Absorption and Emission of Light in Cases of Fluorescence, 449
Woodhead (Sir German), and P. C. Varrier-Jones, Industrial Colonies and Village Settlements for the Consumptive, 172
Woodward (Dr. A. Smith), A New Cave Man from Rhodesia, South Africa, 371; A Skull from Rhodesia, 413, 453, 485
Woodward (Dr. Henry), [obituary article], 93
Worden (E. C.), Technology of Cellulose Esters (in ten volumes). Vol. 1, parts 1 to 5, 266
Wordie (J. M.), elected to a Fellowship at St. John's College, Cambridge, 355; The Geology of Jan Mayen, 554; and Mr. Chaworth-Musters, First Ascent of Beerenberg, Jan Mayen, 128
Wright (G. M.), and S. B. Smith, The Night Behaviour of the Heart-shaped Polar Diagram used in Radio-messages, 97
Wright (W. H.), The Ultra-violet Spectrum of *a* Cygni, 547
Wrigley (J. S.), appointed Assistant Lecturer in Engineering in Manchester University, 262
Wrinch (Dr. Dorothy), and Dr. H. Jeffreys, The Fundamental Principles of Scientific Inference, 318
Wyatt (S.), appointed Special Lecturer in Psychology in Manchester University, 386

Yabe (H.), and S. Endô, Stems of Calamites in the Province of Iwami, 481
York (Duke of), Scientific Research, 347
Yorke (Dr. W.), Marshall and Vassalls' Method of Treatment of Sleeping Sickness, 444
Young, Farnsworth, and Jenkins, Proper Motions of Long-period Variable Stars, 351
Young (Dr. M.), The Regional Distribution of Rheumatic Fever, 444

Zaepffel (E.), Mobile Starch and Geotropism, 103
Zeeman (Prof. P.), Commemoration of his Work on the Decomposition of Spectral Lines by a Magnetic Field, 315

TITLE INDEX.

Aberdeen University, Graduation Ceremony in, 588
Absorption Spectra, Prof. E. C. C. Baly, 311
Acacia Seedlings, R. H. Cambage, 199
Acetone, Researches on the Micro-organisms producing, A. Berthelot and Mlle. E. Ossart, 389
Achirus capensis, The Pectoral Fin of, Dr. J. D. F. Gilchrist, 32
Actinomycetes, The, Dr. W. B. Brierley, 397
Adularia and Moonstone, The Structure of, Dr. A. E. H. Tutton, 352
Aerial: Float, A New, O. Cahen, 263; Photography and Photo-topography, L.-P. Clerc, 292
Aeronautical: Maps, Lt.-Col. E. F. W. Lees, 165; Research Committee, The, 201
Aeronautics, Dr. S. Brodetsky, 36
Aeroplane: Design, The Theory and Practice of, S. T. G. Andrews and S. F. Benson, 36; Patrol for Scaring Ducks, An, 224; Photographs and Map Production, R. B. Unwin, 350; Photography for Archæology, A. P. Trotter, 275; Structures, A. J. S. Pippard and Capt. J. L. Pritchard, with an Introduction by Prof. L. Bairstow, 36
Aeroplanes and Dirigibles in Mist on Dark Nights, Solution of the Problem of the Direction of, W. Loth, 555
Æther: of Space, The, Sir Oliver Lodge, 223; Speech through the, Sir Oliver Lodge, 88; Uniform Motion in the, E. H. Synge, Dr. H. Jeffreys, 80
African Death: Ceremonies, The Influence of Egypt on, T. F. McIlwraith, 163, 418, 583
Agricultural: Botany, National Institute of, 258; Economics: Prof. J. E. Boyle, 79: The Study of, C. S. Orwin (Presidential Address to the Agriculture Section of the British Association), 61, 501; Enterprise, An, 549; Geology, Dr. F. V. Emerson, 7; Meteorology, The Effect of Weather on Crops, J. Warren Smith, 300; Research at Rothamsted, 29
Agriculture: A Tropical College of, 265; and Irrigation in Continental and Tropical Climates, K. D. Doyle, 7; Climatic Factors in, B. A. Keen, 300; How to Teach, A Book of Methods in this Subject, Prof. A. V. Storm and Dr. K. C. Davis, 334; in the Maryut District, west of Alexandria, 585; Ministry of, Leaflets of the, 545; The Progress of, Sir R. Henry Rew, 415
Air, Upper, The International Commission for the Scientific Investigation of the, 255
Aircraft, "Leader" Cables for, 539
Airman's International Dictionary: including the most important Technical Terms of Aircraft Construction, English, French, Italian, German, M. M. Dander, 111
Airship R 38, The Disaster to the, 17; W. L. Jordan; The Writer of the Article, 114
Alcohol, Power and Industrial, with Colonies and Protectorates, Sir C. H. Bedford appointed Honorary Adviser to the Secretary of State for the Colonies on, 25
Alcoholic Grandparents, Influence of, upon the Behaviour of White Rats, E. C. Macdowell and E. M. Vicari, 67
Algebraical Identity, An, R. F. Whitehead, 212
Alinda, the Minor Planet, Finding of, 291
Alizarine, the Synthesis of, Identity of the Dibromoanthraquinone which served for, M. Grandmougin, 357
Allotropie, Die Theorie der, Prof. A. Smits, 298
Alluvial Terraces of Sebou above Fez, The, E. Passemard, 230
Alt-Azimuth Tables, New, 65° N. to 65° S., 206
Alternating-current Bridges, Earth Capacity Effects in, S. Butterworth, 388
Aluminium: Alloys, The Thermal Treatment of Certain Complex, L. Guillet, 486; Constitution and Age-hardening of the Alloys of, with Magnesium and Silicon, Dr. D. Hanson and Marie L. V. Gayler, 198; K and L, Discontinuities of the Absorption of, Critical Potentials relative to the, M. Holweck, 357; The Production of Single Crystals of, and their Tensile Properties, Prof. H. C. H. Carpenter and Constance Elam, 356
American Astronomical Society, Prof. C. V. L. Charlier elected an Honorary Member of the, 190
American Colleges, The Staffing of, 386
Ammon, Note on the Age of the Great Temple of, at Karnak as determined by the Orientation of its Axis, F. S. Richards, 587
Ammonites, Type, S. S. Buckman, 481
Ampère Centenary Celebration, 477
Amundsen's Expedition, Reported Recovery of the Bodies of two lost Men of, 507
Anaphylactic Shock and the Introduction of Precipitates into the Circulation, Relations between the, A. Lumière and H. Couturier, 135
Anaphylactised Animals, The Desensibilisation of, by means of several Antigens, A. Lumière and H. Couturier, 389
Anatomic Illustration in its Relation to Anatomic Science and the Graphic Arts, History and Bibliography of, L. Choulant. Translated and edited by Dr. M. Frank, with additions by Drs. F. H. Garrison and E. C. Streeter, 141
Anatomical Illustration, The History of, Dr. C. Singer, 141
Anatomie, Vorlesungen über vergleichende, Prof. O. Bütschli. 3 Lief.: Sinnesorgane und Leuchtorgane, 236
Ancient Earthworks and Fortified Enclosures, Report of the Committee on, 508
Anderson's Bridge, The Use of, for the Measurement of the Variations of the Capacity and Effective Resistance of a Condenser with Frequency, S. Butterworth, 388
Andes of Southern Peru, The, Geographical Reconnaissance along the Seventy-third Meridian, I. Bowman, 78
Angola, Some Remarkable Rocks from, P. de Sousa, 389
Animal: Light, The Nature of, Prof. E. N. Harvey, 174; Tissues, Measurement of the Influence of Heat and Light on the Activity of Reduction by, and Application to Heliotherapy, J. Vallot, 555
Annealing, The Re-crystallisation produced by, P. Gaubert, 516
Anode Rays and the Determination of the Isotopes in Lithium, etc., G. P. Thomson, 446
Anopheles which do not attack Man, A Biological Race of, B. Grassi, 390
Anophelism and Rabbit-breeding, J. Legendre, 294
Antares and its Companion, F. G. Pease, 193
Anthocyanidines in the Free State in the Flowers and Red Leaves of some Plants, St. Jonesco, 135
Anthocyanine in the Flowers of *Cobaea scandens*, The Formation of, at the Expense of the Pre-existing Glucosides, St. Jonesco, 422
Anthracene and Anthraquinone, E. de B. Barnett, 108
Anthropology: Applied, 329; Dr. N. Annandale, 370; at the British Association, 582
Anti-tuberculosis Work, Practical, 172
Antwerp Royal Geographical Society, The Gold Medal of the, presented to Mrs. Rosita Forbes, 316
Aphthous Fever, Résumé of Experiments on, F. Roux, H. Vallée, H. Carré, and the late M. Nocard, 554
Aplysia, Nellie B. Eales, L.M.B.C. Memoirs, No. 24, 398
Apple Canker: Two Centuries' Practice in its Control, E. R. Swales, 290
Archæology, Aeroplane Photography for, A. P. Trotter, 275
Arctic: Expedition, Stefansson's new, 414; Medusæ, 385; Station, The Danish, Prof. A. C. Seward, 320
Aristotle, The Works of, Translated into English under the Editorship of W. D. Ross. Vol. 10, Politica, B. Jowett; Oeconomica, E. S. Forster; Atheniensium Respublica, Sir Frederic G. Kenyon, 463
Arithmetic of the Decimal System, The, Dr. J. Cusack, 174

Armature Winding, Continuous-current, Elementary Principles of, F. M. Denton, 465
Art, Primitive, The *rationale* of, Prof. Baldwin Brown, 583
Artemia salina from the district of Margherita di Savoia, in Apulia, Cytological Data on the Tetraploidism of, C. Artom, 391
Arthropods, Secondary Sexual Characters in the, Determination of the, R. Courrier, 326
Arthur's Seat Volcano, new Edition of Memoir on the, 225
Ascension and St. Helena, The "Rollers" of, 254
Asia, A Systematic Anthropology of, First Outlines of, Prof. V. Giuffrida-Ruggeri, 578
Asteroid with an Orbit resembling that of a Comet, An, Gonnessiat and Renaux, 454
Astronomical: Instruments, Medieval, in India, G. R. Kaye, 384; Time-keepers and Time-preserving Systems, Studies on, K. Sôtome, 175

ASTRONOMICAL NOTES.

Comets:
Comets, Innes and Wood; Dr. W. Baade, 291; The Origin of Comets, Prof. G. Armellini, 447
Instruments:
Observations with the Cookson Floating Telescope, 480
Meteors:
Large Meteors, W. F. Denning, 28; The August Meteoric Display, P. Meesters, 69; September Meteors, W. F. Denning, 131; Large Fireball, W. F. Denning, 226; The November Meteors, W. F. Denning, 319; The Leonid Meteor Shower, W. F. Denning, 417; The December Meteors, W. F. Denning, 447; Fireballs, W. F. Denning, 511; The January Meteors, W. F. Denning, 580
Planets:
Minor Planets, N. Michkovitch, 69; Conjunction of Venus and Mars, W. F. Denning, 164; The Motion of the Perihelion of Mercury, E. Grossmann, 164; The Lunar Eclipse of Oct. 16, 226, 256; Minor Planets, E. Noteboom, 256; Finding of the Minor Planet Alinda, 291; Observations of Mars at Flagstaff, G. H. Hamilton, 447; Perturbations of Saturn's Rings, Dr. G. R. Goldsbrough, 511; The Markings on Jupiter, F. Sargent, 547
Stars:
Nebular Lines in Spectrum of R. Aquarii, P. Merril, 98; Ionisation in Stellar Atmospheres, Dr. M. N. Saha, 131; Variable Stars, Prof. V. Šafařík, 131; Observations of Star Colours, 164; Antares and its Companion, F. G. Pease; W. S. Adams and A. H. Joy, 193; Studies of Nebulæ and Clusters, C. Flammarion, 193; Morning Stars, 226; The Spectrum of ϕ Cassiopeiæ, Major W. J. S. Lockyer and D. L. Edwards, 256; Observations of Variable Stars, W. J. Luyten, 291; Delineations of the Milky Way, Dr. F. Goos, 319; Proper Motions of Long-period Variable Stars, Young, Farnsworth, and Jenkins, 351; Bright Assemblage of Morning Stars, W. F. Denning, 384; Nova Aquilæ, 384; Star Catalogues, 417; The Effective Wave-length of the Light of Galactic Stars, Prof. O. Bergstrand, 480; The Dynamical Equilibrium of the Stellar System, Prof. A. S. Eddington, 480; The Ultra-violet Spectrum of α Cygni, W. H. Wright, 547; The Furthest Cluster, Dr. H. Shapley and Miss B. W. Mayberry, 580
Sun:
The Total Solar Eclipse of September, 1922, Prof. Campbell, 291; Rubidium in the Sun, Dr. M. N. Saha, 291
Miscellaneous:
Ancient Eclipses, Dr. J. K. Fotheringham, 28; Calendar Dates in Meteorology, J. Mascart, 28; The Bright Object near the Sun, 69; The Bright Object of August 7, 98; Einstein's Real Achievement, Sir Oliver Lodge, 98; The Bright Object near the Sun, Dr W. Bell Dawson, 193; Reform of the Calendar, 256; The Centenary of "Astronomische Nachrichten," 256; Light of the Night Sky, Prof. C. Fabry, 319; The French Wireless Time-signals, 351; The Last Glacial Epoch, C. E. P. Brooks, 351; Medieval Astronomical Instruments in India, G. R. Kaye, 384; A New Suggestion to explain Geological Climatic Changes, Dr. H. Shapley, 417; Observers' Handbook 1922, 511

"Astronomische Nachrichten," Centenary of the, 256
Atlas Météorologique de Paris, J. Lévine, 6
Atmosphere, Thermal Gradient and Vertical Acceleration in the, L. De Marchi, 390
Atmospheric Pressure, The Diurnal Variation of, at Castle O'er and Eskdalemuir Observatory, Dr. A. Crichton Mitchell, 135
Atomic Structure: Prof. N. Bohr, 208; Analysis of the, A. Dauvillier, 516; Problem, Present Status of the, Prof. D. L. Webster and L. Page, 546
Atomic Theory of 1921, The, Dr. J. Moir, 551; The Energetic Bases of the, Prof. G. Urbain, 290
Atomic Volumes and their Optical Refractivities, A Relation between the, G. Le Bas, 272
Aufschotterung und Erosion, Die Ursachen der diluvialen, W. Soergel, 464
Aurora Borealis: of September 28–29, The, Major W. J. S. Lockyer, 180, 370; Terrestrial Magnetic Disturbances, and Sun-spots, Rev. A. L. Cortie, 272
Aurora: Line in the Spectrum of the Night Sky, Occurrence of the, Lord Rayleigh, 208; Polaris, The Position in Space of the, from Observations made at the Haldde Observatory, 1913–14, L. Vegard and O. Krogness, 431
Australia: Diptera Brachycera of, A Preliminary Revision of some Genera belonging to the, G. H. Hardy, 231; Rain Map of, 1920, H. A. Hunt, 27; The Birds of, A Manual of, G. M. Mathews and T. Iredale. Vol. 1: Orders Casuarii to Columbae. 290; The Ocean Currents around, G. H. Halligan, 357
Australian: Botanists, Records of, J. H. Maiden, 357; Coleoptera: New Species of, part xvii., A. M. Lea, 518; Notes and New Species, H. J. Carter, 231; Diptera Brachycera, Studies in the Life-histories of, part i.: Stratiomyiidae. No. 3, Vera Irwin-Smith, 591; Ethnology, Sir Baldwin Spencer, 191; National Research Council, The, 227; Termites, New and Rare, with notes on their Biology, G. F. Hill, 591
Austria: Geography in, Prof. G. A. J. Cole, 100; -Hungary The Successors of, Some of their Problems, Dr. R. W. Seton Watson, 443
Auto-stroboscope, An, and an Incandescent Colour Top, F. L. Hopwood, 589
Aviation: The General Problem of, G. and M. Richard, 389; Theoretico-Practical Text-book for Students, B. M. Carmina, 36
Awards: to Discoverers, W. B. Priest, 498; to Inventors, Royal Commission on, A. Chaston Chapman appointed a Member of the, 223

Babylonian Glass Vase, A Chemical Examination of a, Dr. F. Rathgen, 580
Bacillaria paradoxa, Gmel., in the Staffordshire and Worcestershire Canal, etc., J. W. Williams, 163
"Bacteriophage," Our Knowledge of the, d'Herelle, 252
Balloons, Streamline Kite, The Design and Stability of, with Useful Tables, Aeronautical and Mechanical Formulæ, Capt. P. H. Sumner, 111
Banana, The: Its Cultivation, Distribution, and Commercial Uses, W. Fawcett. Second edition, 270
Battersea Polytechnic: Courses at the, 102; Report for 1920–21, 324
Bed-bug, The, the Host of the Parasite of Kala-azar, Major Patton, 443
Beerenberg, Island of Jan Mayen, Ascent of, 128

Bee-sting and Eyesight, J. W. Gifford, 370
Bees and Scarlet-runner Beans, H. B. Heywood, 147
Beit Memorial Fellowships for Medical Research, Award of, 544
Belfast, Queen's University, Dr. J. K. Charlesworth appointed Professor of Geology in, 166
Bengal, Mechanical Engineering Education in, 323
Benoist, Marcel, Prize awarded to M. Arthus, 190
Berzelius Medal, The, awarded to Prof. E. Abderhalden, 414
Beta vulgaris, Formation of the Red Pigment of, by Oxidation of the Chromogens, A. Kozlowski, 422
Binokularen Instrumente, Die: Nach Quellen und bis zum Ausgang von 1910 Bearbeitet, Prof. M. von Rohr. Zweite Auflage, 109
Biochemistry, Plant, 364
Biological: Statistics, Prof. K. Pearson and Miss A. G. Davin, and others, 70; Terminology, Dr. W. Kidd, 11; Sir G. Archdall Reid, 176, 401; Dr. F. A. Bather, 271; Dr. J. T. Cunningham, 368
Bioluminescence, Physics and Chemistry of, 174
Bird-migration by the Marking Method, The Study of, 220
Birds: and their Eggs in California, Protest against Restrictions imposed upon the Collection of, 252; in Britain, History of, 268; of Australia, A Manual of the, G. M. Mathews and T. Iredale. Vol. 1: Orders Casuarii to Columbae, 299; of the Countryside, Some: The Art of Nature, H. J. Massingham, 142; The Protection of Wild, Earl Grey of Fallodon, 223
Birkbeck College, C. D. Burns appointed Lecturer in Philosophy at, 166
Birmingham University: Bequest to, by Mr. Morton; Closing of Wards in the Birmingham General Hospital, 102; Retirement of W. A. Cope from the Librarianship, 134; L. Eastham appointed Lecturer in Zoology; Miss Laura M. Ligertwood appointed Lecturer in Physiology, 195; Proposed Contribution to the Mining Research Laboratory, 195; appointment of a University Research Committee, 195
Birth-rate, Causes of Fluctuations in the, 105
Bisexuality in Animals, A Function of Motion?, Is, Dr. J. H. Orton, 145; G. C. Robson, 212
Bismuth Sub-salts, The, H. G. Denham, 295
Bitterns, Utilisation of, A. J. Turner, 317
Black Coral as a Charm for Rheumatism, Prof. J. Stanley Gardiner, 505
Blue Hill, Mass., Remarkable July Rainfall at, Dr. A. McAdie, 12
Boronia, The Occurrence of Rutin in the Leaves of the, F. R. Morrison, 591
Boronias, Two pinnate-leaf, and their Essential Oils, with description of a new species, A. R. Penfold and M. B. Welch, 591
Botanic Gardens, The, Victoria, Cameroons Province, Nigeria, Capt. A. W. Hill, 377
Botany, British, Semi-popular, 205
Boyle, Robert, The Resting-place of, Sir William A. Tilden, 176
Brachiomonas, Occurrence of, W. Neilson Jones, 516
Brachyceratops from North-western Montana, C. W. Gilmore, 482
Bradford Technical College, Prospectus of, 102
Brass: Ingots, The Casting of, R. Genders, 197; The Rapid Electro-analysis of, M. and Mme. A. Lassieur, 389
Brazil, Separation of the Meteorological and Astronomical Government Services in, 26
Bright Object near the Sun, The, 69, 98; Dr. W. Bell Dawson, 193
Bristol University: Gifts to, by the Imperial Tobacco Co., Ltd., and C. H. Baker, 354; Prof. T. Loveday appointed Vice-Chancellor of, 419; Impending Diploma in Engineering; Medical Demonstrations, 451; Presentation to Prof. Lloyd Morgan of his Portrait, 514
Britain's Food Supply Basis, 393
British Association, The, 25, 33, 44, 84, 88, 95, 115, 116, 120, 153; Presidential Address to, Sir T. Edward Thorpe, 44; Abstracts of Sectional Presidential Addresses, 56–61; Geography at the, 165; Presidential Address to the Engineering Section of the, Prof. A. H. Gibson, 181; Committee on Training in Citizenship, Report of the, 262; Physical Science at the, 448; Presidential Address to the Agriculture Section of the, C. S. Orwin, 501; Anthropology at the, 582; Meeting, 1922, Presidents and Recorders of the Sections, 576
British: Botany, Semi-popular, 205; Empire Exhibition, 1923, Proposed Commercial Research Fellowships in Connection with the, 386; Empire, Map showing the Chief Sources of Metals in the, 579; Flora, A new: British Wild Flowers in their Natural Haunts, described by A. R. Horwood. Vols. 3, 4, 5, 205; Journal Photographic Almanac, 579; Launderers' Research Association, R. G. Barker appointed Scientific Director of the, 414; Mammals, A. Thorburn (in two vols.), Vol. 2, 364; Medical Association, The, to meet in Glasgow in 1922, 127; Primulas, The Pollination of our, M. Christy, 516; Roses and Hybridity, Dr. Harrison and Miss Blackburn and others, 99; Science Guild, *Journal* of, October, 290; Scientific and Technical Books covering every Branch of Science and Technology, a Catalogue of, carefully classified and indexed, 462; Scientific Instrument Research Association, Third Annual Report of the, 385; Trade Ship, Proposed Floating Exhibition in the, 190
Bronze, low-tin, Effect of Progressive Cold-drawing upon some of the Physical Properties of, W. E. Alkins and W. Cartwright, 198
Brown Bast and the Rubber Plant, G. Bryce; The Writer of the Note, 81
Bruchidæ, Variation and Heredity in the, S. H. Skaife, 295
Bütschli's Lectures on Comparative Anatomy, Prof. G. Elliot Smith, 236

Cadmium, Commercial, Effect of Cold Work on, J. N. Greenwood, 515
Cænolestes, The Affinities of, W. H. Osgood, 67
Calcium Oxalate in the Gidgee Wattle, *Acacia Cambagei*, T. Steel, 103
Calcutta University, conferment of the Honorary Degree of D.Sc. upon Sir W. J. Pope and Prof. C. V. Raman, 553
Calendar: Dates in Meteorology, J. Mascart, 28; of Scientific Pioneers, 31, 71, 103, 134, 167, 197, 230, 262, 293, 324, 356, 387, 420, 452, 484, 515, 553, 589; Eng.-Comdr. E. C. Smith, 567; Reform of the, 256
California, Climatology in, A. H. Palmer, 68
Cambridge Philosophical Society, Election of Officers of the, 348
Cambridge University: Bequests to, by Mrs. L. A. Stuart, 166; Address of Dr. P. Giles; Dr. E. C. Pearce elected Vice-Chancellor, 195; A. B. Appleton, D. G. Reid, A. Hopkinson, and V. C. Pennell re-appointed Demonstrators in Anatomy, 195; E. W. Hulme elected to the Sandars Readership in Bibliography and Palæography, 195; The Admission of Women Question; Col. Sir Gerald Lennox-Conyngham, D. C. Henry, and C. D. Ellis elected Fellows of Trinity College; Col. Sir Gerald Lennox-Conyngham elected Prælector of Geodesy at Trinity College, 229; Dr. O. Inchley appointed Assistant to the Downing Professor of Medicine; C. Warburton re-appointed Demonstrator in Medical Entomology, 261; and Women, 292; Dr. T. S. Hele and Dr. R. A. Peters appointed University Lecturers in Biochemistry; A. Berry re-appointed University Lecturer in Mathematics; A. G. Evans awarded the Raymond Horton-Smith Prize, 292; Presentation of an Address to Dr. G. D. Liveing, 354; J. M. Wordie elected to a Fellowship at St. John's College; Approval of New Statutes, 355; Press, A History of the, 1521–1921, S. C. Roberts, 365; Dr. J. Chadwick elected to a Fellowship at Gonville and Caius College, 386; W. E. H.

Berwick elected to a Fellowship at Clare College, 419; Opening of the Molteno Institute for Parasitology, 514
Cameroons and Nigeria, Account of a Visit to the, Dr. A. W. Hill, 253, 454
Canadian: Arctic Expedition, 1913–18, Work of the, V. Stefansson, 349; Insect Pests, 261; Institute of Chemistry, Sir William J. Pope elected an Honorary Fellow of the, 127
Cane-sugar, The Fermentation of, by Yeast and the Development of Electromotive Force, Prof. M. C. Potter, 446
'Canny Ryall" Portable Diathermy Apparatus, The, 446
Cantal, The Complexity of the Volcanic Massif of, and the True Nature of the Puy Mary, P. Glangeaud, 389
Carbon Monoxide: Individual Protection against, Desgrez, Guillemard, and Hemmerdinger, 294; in Public Gas Supplies, 521
Carborundum, Use of, for Ruling Test Plates, W. C. Cady, 370
Cass, Sir John, Technical Institute, Syllabus of Courses of the, 71
ϕ-Cassiopeiæ, The Spectrum of, Major W. J. S. Lockyer and D. L. Edwards, 256
Cavendish, The Hon. Henry: The Scientific Papers of. Vol. i.: The Electrical Researches; Vol. ii.: Chemical and Dynamical, 4
Cave Man, A New, from Rhodesia, South Africa, Dr. A. Smith Woodward, 371
Cell-division, J. Gray, 554
Cells, The Permeability of, Prof. Hamburger, 545
Cellulose Esters, Technology of (in 10 vols.), E. C. Worden. Vol. 1, parts 1 to 5, 266
Census of 1921, The, 1
Ceratium and Pedalion, A. E. Harris, 340
Ceratium furca and *Pedalion mirum*, A. E. Harris, 42
Ceremonial Avoidance of Contact with the Ground, F. W. H. Migeod, 583
Chaldæan Society, Annual General Meeting of the, 288
Charophyta collected by Mr. T. B. Blow in Ceylon, J. Groves, 421
Chemical: Notes, Botanical, T. Steel, 591; Reactivity and the Quantum Theory, Dr. E. K. Rideal, 259; Warfare, Brig.-Gen. A. A. Fries and Major C. J. West, 492; Sir T. E. Thorpe, 331
"Chemist," The Denomination, 458
Chemistry: Applied, 138; Award of National Certificates in, Scheme for the, 452; Colloid: Research Problems in, Prof. W. D. Bancroft, 586; The Need of Research in, W. Clayton, 586; of Anthracene, Dr. M. O. Forster, 108; of Plant Life, The, Dr. R. W. Thatcher, 364
Chemists' Year Book, The, 1921. Edited by F. W. Atack, assisted by L. Whinyates. 2 vols., 9
Child's Path to Freedom, The, N. MacMunn, 79
Chimie, L'Espace dans la, 171
China, North-west, Travels of a Consular Officer in, E. Teichman, 234
Chlorine, The Separation of, into Isotopes, Prof. W. D. Harkins, 209
Chlorocrepis in the Tribe of the *Chicoraceae compositae*, Re-establishment of the Genus, Mlle. Marcelle Guéraud, 357
Cholera Risks, 73
Christian Philosophy, Studies in, being the Boyle Lectures, 1920, Rev. Prof. W. R. Matthews, 559
Christian Theism, Rev. Dr. F. R. Tennant, 559
Chromium: Ore, W. G. Rumbold, 268; Platinum, and Lead Ores, 268
Chromosome Theory of Heredity, The, J. S. Huxley, 289
Chrysalids, Metallic Coloration of, A. Mallock, 302; Hon. H. Onslow, 366
Civil Engineers, Institution of, Awards of the, 576
Classics: and Education, Report of Committee, 64; The Use of the, W. M. F. P., 180
Clayworker's Handbook, The, A. B. Searle. Third edition, 398
Cleveland Technical Institute, Middlesbrough, Opening of the, 196
Climate, Variations of, since the Ice Age, C. E. P. Brooks, 90
Clockmakers' Company, Sir Frank Dyson elected Master of the, 223
Clock Mechanism and of Pendulums employed in Astronomy, The Synchronisation of, M. d'Azumbuja, 199
Clostridium Pastorianum as Nitrogen-fixing Organisms, The Variations of Energy of, G. Truffaut and M. Bezssonnof, 422
Cloud: Heights at Night, A Method of Finding, 577; Phenomenon of November 29, 1920, The, C. J. P. Cave, 453
Cluster, The Furthest, Dr. H. Shapley and Miss B. W. Mayberry, 580
Coal: Mines, Spontaneous Combustion in (Final Report of the Departmental Committee), 132; Oxidation of, The Determination of the Degree of, G. Charpy and G. Decorps, 422
Collectors, Handbook of Instructions for, Fourth edition, 112
Colloid Chemistry: Research Problems in, Prof. W. D. Bancroft, 586; The Need of Research in, W. Clayton, 586
Colloidal State, Notes on, etc., E. O. Hercus and Prof T. H. Laby, 387
Colour: and Chemical Constitution, J. Moir, part 15, 422; part 16, 518; Reaction, A, Common to Antiscorbutic Extracts and Hydroquinone, M. Bezssonnof, 135
Comets: Innes and Wood; Dr. W. Baade, 291; The Origin of, Prof. G. Armellini, 447
Communism and Science, Dr. J. W. Mellor, 113
Conde de Churruca, Trials of the, 163
Consciousness and the Unconscoius, Prof. C. Lloyd Morgan (Presidential Address to the Psychology Section of the British Association), 213
Consumptive, Industrial Colonies and Village Settlements for the, Sir German Woodhead and P. C. Varrier-Jones, with a Preface by Sir Clifford Allbutt, 172
Cookson Floating Telescope, Observations with the, 480
Co-operative Indexing of Periodical Literature, H. W. Wilson; The Writer of the Article, 43
Copper: The Working and Annealing of, Dr. F. Johnson, 198; Lead, Antimony, and Tin, The Separation and Estimation of, A. Kling and A. Lassieur, 516
Copper Eskimo of Coronation Gulf, The, D. Jenness, 478
Coptotermes Raffrayi, Wasman (fam. Termitidæ), G. F. Hill, 104
"Cornalith" and "Galalith," Erinoid, Ltd., 130
Corpuscular Spectra of the Elements, The, M. and L. de Broglie, 230
Correlation, On, A. Guldberg, 319

CORRESPONDENCE

Aeroplane Photography for Archæology, A. P. Trotter, 275
Æther, Uniform Motion in the, E. H. Synge; Dr. H. Jeffreys, 80
Airship R 38, The Disaster to the, W. L. Jordan; The Writer of the Article, 114
Algebraical Identity, An, R. F. Whitehead, 212
Anthropology, Applied, Dr. N. Annandale, 370
Atomic: Structure, Prof. N. Bohr, 208; Volumes and their Optical Refractivities, A Relation between the Combined, G. Le Bas, 272
Aurora: Borealis, Terrestrial Magnetic Disturbances, and Sun-spots, Rev. A. L. Cortie, 272; Line in the Spectrum of the Night Sky, Occurrence of the, Lord Rayleigh, 208
Auroral Display of September 28–29, Major W. J. S. Lockyer, 180, 370
Awards to Discoverers, W. P. Priest, 498
Bee-sting and Eyesight, J. W. Gifford, 370
Bees and Scarlet-runner Beans, H. B. Heywood, 147
Beetles, Metallic Colouring of, A. Mallock, 432
Biological Terminology, Dr. W. Kidd, 11; Sir G. Archdall

Reid, 176, 401; Dr. F. A. Bather, 271; J. T. Cunningham, 368
Bisexuality in Animals a Function of Motion? Is, Dr. J. H. Orton, 145; G. C. Robson, 212
Boyle, Robert, The Resting-place of, Sir W. A. Tilden, 176
Brightness in the Penumbra during an Eclipse of the Moon, The Distribution of, F. J. W. Whipple, 497
Brown Bast and the Rubber Plant, G. Bryce; The Writer of the Note, 81
Calendar of Scientific Pioneers, The, Eng.-Comdr. E. C. Smith, 567
Carborundum for Ruling Test Plates, Use of, W. G. Cady, 370
Ceratium and Pedalion, A. E. Harris, 340
Ceratium furca and *Pedalion mirum*, A. E. Harris, 42
Chlorine, The Separation of, into Isotopes, Prof. W. D. Harkins, 209
Chrysalids, Metallic Coloration of, A. Mallock, 302; Hon. H. Onslow, 366
Classics, The Use of the, W. M. F. P., 180
Communism and Science, Dr. J. W. Mellor, 113
Co-operative Indexing of Periodical Literature, H. W. Wilson, 43
Cosmic Friction: A Query, Sir Oliver Lodge, 275
Courtship, The Accessory Nature of many Structures and Habits associated with, J. S. Huxley, 565
Cylindrical Surfaces, Reflection from, C. O. Bartrum, 436
Dushman Equation for the Velocity of a Monomolecular Reaction, The, W. E. Garner, 211
Earth, The Age of the, Lord Rayleigh, 335; Dr. H. Jeffreys, 370
Echinoderm Larvæ and their Bearing on Classification, Prof. E. W. MacBride, 529; Dr. F. A. Bather, 530
Electric Telegraph, The, J. C. Carter; The Writer of the Note, 568
Elongated Bodies to set in the: East and West Direction, The Tendency of, W. D. Lambert, 528; North and South Direction, The Tendency of, Sir Arthur Schuster, 240; Col. E. H. Grove-Hills, 403; E. A. Reeves, 433
Evolution, Some Problems in, W. R. Bousfield, 530; Prof. E. S. Goodrich, 531
Film-photophone, The, W. S. Gripenberg; The Writer of the Note, 307
Flames, Simple Sensitive, G. A. Sutherland, 532
Gold-coloured Teeth of Sheep, T. Steel, 242
Hearing, The Resonance Theory of, Dr. W. Perrett, 569
Heath-fires, The Generation of, H. Bury, 83
Hedgehog, Habits of the, 242
Highest Inhabited House, The, W. Harcourt-Bath; The Reviewer, 179
Hybridity and the Evolution of Species, Prof. J. P. Lotsy; The Writer of the Article, 274; Prof. J. P. Lotsy, 400; Prof. R. Ruggles Gates, 401; Prof. J. Brontë Gatenby, 469
Hydrogen-ion Concentration of the Soil to Plant Distribution, Relation of the, Dr. W. R. G. Atkins, 80, 568; M. N. Comber, 146; E. A. Fisher, 306
Indian Land Mollusca, Dr. N. Annandale, 180, 340; Sir A. E. Shipley, 271
Industries Act, 1921, Safeguarding of, Prof. L. Bairstow and Major A. G. Church, 271
Inheritance, Mendelism, and Mutation, Sir G. Archdall Reid, 335
Ionisation Currents, The Measurement of, by Three-electrode Valves, J. C. M. Brentano, 532
Japanese Culture Pearls, Dr. H. Lyster Jameson, 528
Life and Mind, Sesamy, 83
Light in Liquids and Solids, The Molecular Scattering of, Prof. C. V. Raman, 402
Limnaea peregra, Sinistral, Prof. A. E. Boycott, 403
Lizards, Behaviour in, E. L. Gill, 179
Lumbricus terrestris, L., Müll., Penial and Genital Setæ of, Dr. J. Stephenson, 337
Materialism, Relativity and, Dr. N. R. Campbell, 399; Prof. H. Wildon Carr, 400; H. Elliot, 432; Prof. H. Wildon Carr; Canon E. McClure, 467; Dr. H. Jeffreys, 568; S. V. Ramamurty; Dr. N. R. Campbell, 569
Metaphysics and Materialism, Dr. Norman R. Campbell, 399; Prof. H. Wildon Carr, 400
Mercury, The Separation of, into Isotopes, Prof. W. D. Harkins and R. S. Mulliken, 146
Micro-barograph, A Simple, A. Wechsler, 469
Microscope Illumination and Fatigue, H. J. Denham, 369, 496; J. E. Barnard, 468, 566
Molecules, The Constitution of, Prof. J. R. Partington, 242
Newt and Slow-worm, Breeding Periods of, R. Elmhirst, 179
Nomenclature, Curiosities of, Rev. T. R. R. Stebbing, 340
Ophion luteus, Sir Herbert Maxwell, 339, 436; Dr. C. J. Gahan; R. Stenton, 403
Optical Industries, The Development of, J. W. Atha & Co., 238; The Writer of the Article, 239; Dr. J. W. French, 304; M. P. Swift; Prof. K. C. Browning, 305
Oyster: Sex-change in the Native, W. L. Calderwood, 272; Spat (1921), An, with Mature Male Sexual Products, Dr. J. H. Orton, 500
Pearls, Japanese Culture, Dr. H. Lyster Jameson, 528
Peronospora Schleideni, Unger, The Presence of Perennial Mycelium in, P. A. Murphy, 304
Philosophical Magazine, The, Sir Oliver Lodge, 12
Physiological Phenomenon, A Curious, F. C. Dannatt; Prof. T. Graham Brown, 529
Pickering Series in O Type Stars, The, H. H. Plaskett, 210
Piezo-electricity? Muscular, E. W. Russell, 275; F. Buchanan, 340
Pisidium clessini in British Lochs, A. W. Stelfox, 40
Plankton, Illumination of, Lt.-Comdr. G. C. C. Damant, 42
Prismatic Structure in Optical Glass, Dr. J. Weir French, 567
"Radiant" Spectrum, The, Prof. C. V. Raman, 12; Dr. H. Hartridge, 467
Radiation and Chemical Action, T. W. J. Taylor, 210; Prof. W. C. McC. Lewis, 241
Radio-elements, The Isotopy of the, Dr. M. L. Neuburger, 180
Radium Equivalent, The Designation of the, N. E. Dorsey, 40
Rainfall, July, Remarkable, at Blue Hill, Mass. Dr. A. McAdie, 12
Rainfall Records at Rothamsted, W. D. Christmas, 307
Reflection "Halo" of (Semi-) Cylindrical Surfaces, J. H. Shaxby, 369
Relativity: Particles starting with the Velocity of Light, Prof. E. Kasner, 434; and Materialism, H. Elliot, 432; Prof. H. Wildon Carr; Canon E. McClure, 467; Dr. H. Jeffreys, 568; S. V. Ramamurty; Dr. N. R. Campbell, 569
Rothamsted, Rainfall Records at, W. D. Christmas, 307
Ruling Test Plates for Microscopic Objectives: Sharpness of Artificial and Natural Points, A. Mallock, 10
Russ, Dr., The Apparatus of, Prof. C. V. Boys, 40
Russia, Scientific Workers in, Prof. V. Korenchevsky, 469
Scarlet-runner Beans, Bees and, H. B. Heywood, 147
Science, Communism and, Dr. J. W. Mellor, 113
Science," The "Proletarisation of, in Russia, Dr. H. Lyster Jameson, 147; Prof. B. Brauner, 367
Scientific: Inquiry a Criminal Occupation? Is, Prof. H. E. Armstrong, 241; Periodicals, World List of, Prof. W. W. Watts, 531; Publication, Dr. W. B. Brierley, 41; Dr. F. A. Bather; J. A. H., 144; C. A. Hoare, 179
Sea, The Colour of the, Prof. C. V. Raman, 367
Sex: -change in the Native Oyster, W. L. Calderwood, 272; -manifestations and Motion in Molluscs, Dr. J. H. Orton, 303; G. C. Robson, 403
Smoke-veil, The, Dr. W. L. Balls, 499
"Smoky" Quartz, Prof. C. V. Raman, 81
Snails, The Dispersal of, by Birds, Prof. T. D. A. Cockerell, 496
Space–Time Co-ordinates, A System of, J. L. Synge, 275
Speaking Films, L. Pendred, 338; Prof. A. O. Rankine, 339
Sunlight: The Action of, A Case for Inquiry, Dr. C. W. Saleeby, 466; Sir Oliver Lodge, 496
Sunrise: and Sunset, The Duration of, Dr. W. J. Fisher,

211; The Duration of, Old Observations bearing on, Dr. W. J. Fisher, 531
Sunset, Duration of, Table for the, Dr. W. J. Fisher, 433
Terrestrial Magnetic Disturbances and Sun-spots, J. Evershed, 566
Thistledown, The Flight of, Prof. Miles Walker, 242; W. E. Lishman; L. F. Richardson, 340; Prof. J. Small, 500
Tin Plague and Scott's Antarctic Expedition, Prof. Alan W. C. Menzies, 496
University Relief for Central Europe and Russia, Sir Maurice de Bunsen, 435
Valency, Qualities of, Dr. R. M. Caven, 210; Dr. S. H. C. Briggs, 306
Visibility: Methods of Improving, A. G. Lowndes; Capt. Sir D. Wilson-Barker, 337; of Distant Objects, A Method of Improving, Prof. C. V. Raman, 242
Vowel Sounds, The Nature of, P. Edwards; Prof. E. W. Scripture, 82
Water, Boiled and Unboiled, The Differentiation of, Dr. W. R. G. Atkins, 339
Waves in an Isotropic Solid, Propagation of, A. Mallock, 465
Whispering-gallery Phenomena at St. Paul's Cathedral, Prof. C. V. Raman and G. A. Sutherland, 42
X-rays: Absorption of, W. E. Williams and B. L. Worsnop, 308; Secondary, The Softening of, Prof. A. H. Compton, 366; S. J. Plimpton, 402; Dr. J. A. Gray, 435
Zoological Record, The, W. L. Sclater, 436

Cosmic Friction: A Query, Sir Oliver Lodge, 275
Cotton Research Board, Ministry of Agriculture, Egypt, First Annual Report (1920) of the, 30
Counsels and Ideals: From the Writings of William Osler. Second edition, 430
Countries as Personalities, Prof. H. J. Fleure (Citizens' Lecture in connection with the British Association), 573
Countryside Rambles, W. S. Furneaux, 207
Courtship, The Accessory Nature of Many Structures and Habits associated with, J. S. Huxley, 565
Crop Production, Science and, Dr. E. J. Russell (Farmers' Lecture of the British Association), 116
Cuckoo, A Kinematograph Film illustrating the, E. P. Chance, 415, 421
Cuprous Compounds, Contribution to the Knowledge of the, J. Errera, 230
Curite, A New Radio-active Mineral, A. Schoep, 555
Currents, Stray, Researches on, J. Chappuis and Hubert-Desprez, 454
a Cygni, The Ultra-violet Spectrum of, W. H. Wright, 547
Cypræidæ, The Family, E. Vredenburg, 481

Dairy Bacteriology, Prof. Orla-Jensen, translated by P. S. Arup, 431
Dam, The Most Economical Height of a, A. D. Mead, 445
Danish: Arctic Station, The, Prof. A. C. Seward, 320; Deep Sea Expedition, The, Dr. J. Schmidt, 185
Darwin's Birthplace purchased by H.M. Office of Works, 190
Death, Feigning, Habit of, among Animals, L. Bertin, 224

DEATHS.

Allen (Dr. J. A.), 94, 475
Armstrong (Prof. F. E.), 315, 346
Baillie-Grohman (W. A.), 475
Bainbridge (Prof. F. A.), 315, 344
Baynes (R. E.), 94
Bevan (E. J.), 314
Bourget (H.), 412
Boutroux (E.), 413, 441
Brady (Dr. G. S.), 575
Bruce (Dr. W. S.), 315, 345
Chapman (Dr. T. A.), 542
Cousins (Dr. J. W.), 221
Delépine (Prof. A. S.), 379, 412
Dodds (J. M.), 380, 506
Donop (Lt.-Col. P. G. von), 413
Ducie (Earl of), 315
Fischer (L. A.), 24
Fox (Sir C. Douglas), 380, 412
François-Franck (Prof. C.), 314
Frazer (R. W.), 476
Freyer (Sir Peter J.), 94
Garforth (Sir William), 285
Godlewski (Prof. T.), 380
Grandidier (A.), 286
Halsbury (Lord), 506
Hann (Prof. J. von), 221, 249
Harley (Dr. J.), 575
Harrison (B.), 251
Hewitt (Dr. P. C.), 188
Kennedy (Sir John), 442
Ladd (Prof. G. T.), 23
Lambert (Prof. C. J.), 413
La Touche (Sir James D.), 221
Leyton (Dr. A. S. F.), 284
Lindley (Lord), 506, 541
Lock (Rev. J. B.), 94
Mann (Prof. G.), 221
Montelius (Dr. O.), 379
Newland (B.), 189
Norman (Major G. H.), 94
Oertling (H. R. A.), 575
Pannell (J. R.), 127
Passmore (Dr. F. W.), 379
Richards (E. Windsor), 379
Richards (Prof. J. W.), 286
Ridewood (Dr. W. G.), 160
Roe (J. P.), 127
Sladen (F. W. L.), 127
Sloog (H.), 346
Thompson (Prof. P.), 413, 441
Thomson (J.), 221
Walker (G. W.), 94, 188
Woodward (Dr. Henry), 93

Decimal: Association, Resolution of the, 477; System, The Arithmetic of the, Dr. J. Cusack, 174
Dental Decay, Appointment of a Committee on the Causes of, 163
Descent, Theory of, The Present Position of the, in Relation to the Early History of Plants, Dr. D. H. Scott (Presidential Address to the Botany Section of the British Association), 153
Devonian, The Base of the, with Special Reference to the Welsh Borderland, L. D. Stamp, 453
Dibenzoylmethane of Wislicenus, The Supposed True, Some New Experiments, C. Dufraisse and P. Gérald, 486
Diet in Relation to Normal Nutrition, Dr. J. M. Hamill, 444
Diffraction of Plane Electromagnetic Waves by a perfectly Reflecting Sphere, The, F. P. White, 421
Dimethylcampholamide, The Reduction Products of, A. Haller and Mme. P. Ramart, 357
Direct-current: Dynamos and Motors, The Theory of, J. Case, 461; Electrical Engineering, The Elements of, H. F. Trewman and G. E. Condliffe, 431
Dirigible Balloon in Sea-fishing, The Co-operation of the, H. Heldt, 517
Dogfishes, The Life-history of the, E. Ford, 585
Domestic Heating and Waste of Coal and Health, 560
Drought: of 1921, Could the, have been Forecasted?, C. E. P. Brooks, 350; The Recent, The Extent of, 15
Dunstable, The Mound-builders of, Prof. G. Elliot Smith and Capt. G. Crowden, 512
Durham University: G. S. Mockler appointed Lecturer in Geology in, 71; College of Medicine, Dr. D. Burns appointed Professor of Physiology in the, 134
Dushman Equation, The, for the Velocity of a Monomolecular Reaction, W. E. Garner, 211

Dye : Chemistry, The Fundamental Processes of, Prof. H. E. Fierz-David, translated by Dr. F. A. Mason, 138 ; Printing Photographic Process, A New, Dr. J. M. Eder, 383
Dynamics, Notes on, with Examples and Experimental Work, T. Thomas, 207

Earth : Influence of the Size of the, on Certain Changes in Terrestrial Magnetism, Prof. W. F. G. Swann, 130 ; Movements at Burrinjuck, as recorded by Horizontal Pendulum Observations, Dr. L. A. Cotton, 199 ; Structure, Prof. G. A. J. Cole, 236 ; The Age of the, 217 ; Lord Rayleigh, 279, 335 ; Prof. W. J. Sollas, 281 ; Prof. J. W. Gregory, 283 ; Dr. H. Jeffreys, 284, 370 ; The Rotation of the, W. D. Lambert, 192
Earthquake-rift, Tracing the Course of a Great, by Photography from an Aeroplane, B. Willis, 416
Earthquakes in 1916, The World's, G. Agamennone, 390
Eastern Province, The Aboriginal Tribes of the, I. Hewitt, 545
Echinoderm Larvæ and their Bearing on Classification, Dr. F. A. Bather, 459, 530 ; Prof. E. W. MacBride, 529
Echinoderms, Studies of the Development and Larval Forms of, Dr. Th. Mortensen, 459
Eclipse, Next Year's Total Solar (September 21, 1922), Major W. J. S. Lockyer, 570
Eclipses, Ancient (Halley Lecture), Dr. J. K. Fotheringham, 28
Edinburgh : and East of Scotland College of Agriculture, Calendar of the, 31 ; and the Rise of Oceanography, Prof. W. A. Herdman (an evening discourse to the British Association), 308 ; in the Medieval Period, F. C. Mears, 165 ; To-day, The Beauty of, Prof. P. Geddes, 165 ; Place in Scientific Progress, 75
Edinburgh University : A New Science Ordinance ; proposed Tait Chair of Natural Philosophy ; Institution of New Courses ; the Income of the John Newland Endowment, 323
Education, Classical and Modern, W. Bateson, 64
Egypt : Cotton Research in, 30 ; Irrigation Problems in, 68 ; Orientation in, Col. H. G. Lyons, 587 ; Physical Department of the Ministry of Public Works, Report of the Work of the, 225 ; The Importance of Scientific Research in, 68 ; The Influence of, on African Death Ceremonies, T. F. McIlwraith, 418
Einstein's Real Achievement, Sir Oliver Lodge, 98
Electric : and Magnetic Activity of the Sun and the Earth and Interpretations, Measurements of the, Dr. L. A. Bauer, 446 ; Furnaces in the Iron and Steel Industry, W. Rodenhauser, J. Schoenawa, and C. H. Vom Baur. Translated by C. H. Vom Baur. Third edition, 562 ; Telegraph, The, J. C. Carter ; The Writer of the Note, 568 ; Waves, The Measurement of the Velocity of Propagation of, along Metallic Wires, M. Mercier, 389 ; Welding, A New Method of Automatic, L. J. Steele and H. Martin, 547
Electrical : Engineering, Dr. T. F. Wall, 205 ; Engineers, Institution of, Lord Southborough elected an Honorary Member of the, 413 ; Transmission of Photographs, The, M. J. Martin, 334
Electrician, The Diamond Jubilee of the, 381
Electricity Commissioners, First Annual Report of the, 288
Electrified Liquids, The Surface Tension of, F. Michaud, 486
Electro-deposition and Electro-plating, Account of Discussion on, 479
Electro-deposition of Copper and its Industrial Applications, The, C. W. Denny, 564
Electrolysis of Aqueous Solutions of Alkaline Nitrates, etc., F. H. Jeffery, 516
Electromagnetic Force, Tubes of, E. T. Whittaker, 486
" Electron," The Magnesium Alloy, S. Beckinsale, 198
Electronic Conception of Valence, The, and the Constitution of Benzene, Prof. H. S. Fry, 77
Electrotechnical Theory, 461
Elongated Bodies : to set in the North and South Direction, The Tendency of, Sir Arthur Schuster, 240 ; Col. E. H. Grove-Hills, 403 ; E. A. Reeves, 433 ; to set in the East and West Direction, The Tendency of, W. D. Lambert, 528
Emin Pascha, Dr., Die Tagebücher von, Band 6, 397
Emin Pasha's Last Collections, Sir H. H. Johnston, 397
Empire Forestry Association, Inauguration of the, 413
Emulsion : from Almonds, The Action of, on Lactose in 85 per cent. Ethyl Alcohol, M. Bridel, 199 ; An Inhibition Period in the Separation of an, T. C. Nugent, 516
Engineer, The Education of an, J. S. Highfield, 381
Engineering : Electrical, Dr. T. F. Wall, 205 ; Electricity, Prof. R. G. Hudson, 461 ; Illuminating, The Elements of, A. P. Trotter, 365
Engineers, Society of, Awards of the, 576
England, North : An Economic Geography, L. R. Jones 495
Entomological Discoveries, Two, in India, Dr. F. F. Laidlaw, 129
Entomologists' Monthly Magazine, August, 224
Entropologische Gottesbeweis, Der : Die physikalische Entwicklung des Entropieprinzips, seine philosophische und apologetische Bedeutung, Dr. J. Schnippenkötter, 527
Environment, The Influence of, upon Development, F. Boas, 263
Erde, Der Bau der, Prof. L. Kober, 236
Erythrophloeum Laboucherii, The Active Principle of, J. M. Petrie, 231
Escapements and Quanta, Sir Joseph Larmor, 254
Etoiles, Le Destin des : Etudes d'Astronomie Physique, S. Arrhenius. Traduction française par T. Seyrig, 207
Euclidean Geometry of Angle, The, D. K. Picken, 486
Eugenics, Impending Problems in, Prof. I. Fisher, 252
Euphorbia tibetica, A Rust on, S. K. Pandé, 591
Everest, Mount, Lieut.-Col. H. H. Godwin-Austen, 409 ; Expedition, 66, 161, 213, 348, 476, 577 ; Leadership accepted by Brig.-Gen. the Hon. Charles Bruce, 414
Evolution, Some Problems in, Prof. E. S. Goodrich (Presidential Address to the Zoology Section of the British Association), 404, 531 ; W. R. Bousfield, 530
Extrusion Defect, The, R. Genders, 198
Eyepieces, Achromatic one-radius Doublet, J. W. Gifford, 589

Faraday : and the Quantum, Dr. H. S. Allen, 341 ; Society, Election of Officers and Council, 544
Fauna : of British India, including Ceylon and Burma : Mollusca.—III. Land Operculates (Cyclophoridae, Truncatellidae, Assimineidae, Helicinidae), G. K. Gude, 106 ; The Preservation of our, T. A. Coward, 513 ; Wild, Conservation of, in America, 383
Ferguson Fellow for Research in Applied Chemistry, H. Hyman appointed, 589
Fields, The Story Book of the, J. H. Fabre, 270
Fijian Society : Institution and Behaviour in, W. J. Perry, 139 ; or, The Sociology and Psychology of the Fijians, Rev. W. Deane, 139
Film-photophone, The, Dr. W. S. Gripenberg ; The Writer of the Note, 307
Films, Speaking, Prof. A. O. Rankine, 276, 339 ; L. Pendred, 338
Fireball, Large, W. F. Denning, 226
Fireballs, W. F. Denning, 511
Fish, Baby, Food of the, Dr. Marie Lebour, 585
Fisheries : Biology, 585 ; Deputy Minister of, the Earl of Ancaster appointed to act as, 316 ; Scottish, Prof. W. C. McIntosh, 228
Fishes, Freshwater, and How to Identify Them, Dr. S. C. and W. B. Johnson, 79
Flames, Simple Sensitive, G. A. Sutherland, 532
Flora : British, A New, British Wild Flowers in their Natural Haunts, described by A. R. Horwood, Vols. 3, 4, 5, 205

Fluorescence, Absorption and Emission of Light in Cases of, The Time-interval between the, Prof. R. W. Wood, 449
Fluorine, A New Method for the Estimation of, at the Ordinary Temperature, M. Travers, 422
Fly, The Domestic, Fertility and Longevity of the, E. Roubaud, 517
Folk-lore: Attitude of 16th and 17th Century, to Fairies and Witches, Canon J. A. MacCulloch, 583; Scottish, The Peculiar Features of, Dr. D. MacKenzie, 583
Food: Investigation Board, Report of the, for 1920, 513; Researches on, 513
Foraminifera, Species in, 70
Forestry, Allocation to, from the Unemployment Fund, 349
Formaldehyde: and Carbohydrates from Carbon Dioxide and Water, The Photosynthesis of, Prof. E. C. C. Baly, Prof. I. M. Heilbron, and W. F. Barker, 290; Hydrosulphite, A New Preparation of, and an Economical Generator of Hydrosulphurous Acid, P. Malvezin, C. Rivalland, and L. Grandchamp, 555
Formosanarum, Icones Plantarum, necnon et Contributiones ad Floram Formosanam, B. Hayata, Vol. 10, 237
Fossil: Bryozoa (Polyzoa), Catalogue of the, in the Department of Geology, British Museum (Natural History). The Cretaceous Bryozoa (Polyzoa). Vol. 3. The Cribrimorphs. Part 1, Dr. W. D. Lang, 39; Insect Wings, Two, in the Collection of Mr. John Mitchell, from the Upper Permian of Newcastle, N.S.W., belonging to the order Hemiptera, Dr. R. J. Tillyard, 591
France: Les Ressources du Travail Intellectuel en, E. Tassy and P. Léris, 270; Northern and Eastern, The Position of the Metallurgical Industries of, L. Guillet, 255
Franco-Anglo-Egyptian Frontier, The, and the Line of Watershed between the Basins of the Nile and Lake Tchad, M. Tilho, 294
French Wireless Time-signals, The, 351
Freshwater Fishes and How to Identify Them, Dr. S. C. and W. B. Johnson, 79
Frogs' Eggs, Pigmentation of, L. Harrison, 517
Fruits of the Tropics and Subtropics, 334
Fuel: Consumption, Domestic, A. H. Barker, 560; Problems and Prospects, Prof. J. W. Cobb, 18; Problems of the Future (the "James Forrest" Lecture), Sir George Beilby, 18; Research Board, Report of the, for the years 1920–21. First Section: Steaming in Vertical Gas Retorts, 451

Galactic Stars, The Light of, The Effective Wave-length of, Prof. O. Bergstrand, 480
Galactose, Preparation of, 318
Gas: Regulation Act, 1920. Report to the Board of Trade of the Departmental Committee on Carbon Monoxide, 521; Warfare, 492
Gaseous Molecules of which Hydrogen is a Constituent, The Structure of some, Prof. A. O. Rankine, 590
Gelatine, The Titration Curve of, Dorothy J. Lloyd and C. Mayes, 485
Geographical Society of Paris, Centenary of the, 288
Geography: Applied, Dr. D. G. Hogarth (Presidential Address to the Geography Section of the British Association), 58, 120; at the British Association, 165; for Junior Classes, E. Marsden and T. A. Smith, 527; in Austria, Prof. G. A. J. Cole, 100; The Teaching of, G. G. Chisholm, and others, 260
Geological: Climatic Changes, A New Suggestion to Explain, Dr. H. Shapley, 417; Excursion Handbook, A, for the Bristol District, Prof. S. H. Reynolds, Second edition, 10; Maps, The Study of, Dr. Gertrude L. Elles, 301; Survey Board and the Director, Report of the, for 1920, 509
Geology: Experimental, Dr. J. S. Flett, 57; of the Non-metallic Mineral Deposits other than Silicates. Vol. 1, Principles of Salt Deposition, Dr. A. W. Grabau, 112; of the South Wales Coalfield, 257
Geometrical Optics, The Future of, 109
Geometry, Practical, for Builders and Architects, J. E. Paynter, 564
German Reparations and Electrical Industries, 543
"Ghost Micrometer," The, Prof. H. H. Dixon, 350
Giants, Prof. W. D. Halliburton, 128
Glacial Epoch, The Last, C. E. P. Brooks, 351
Glacially Striated Pavement, A, in the Kuttung Series of the Maitland District, G. D. Osborne and W. R. Browne, 103
Glaciers, Depth of, C. Somigliana, II., 389; III., 390
Glasgow: Royal Technical College, Annual Report of the, 355, Calendar of the, 229; University, S. H. Tucker appointed Lecturer in Organic Chemistry, 102; Dr. P. A. Hillhouse appointed John Elder Professor of Naval Architecture and Marine Engineering, Dr. W. J. Goudie appointed James Watt Professor of the Theory and Practice of Heat Engines, and Dr. G. W. O. Howe James Watt Professor of Electrical Engineering, 261
Glass: Effect of Rays from Radium, etc., on, J. R. Clarke, 290; Manufacture, The Practical Value of the Microscope in, R. L. Frink, 453; The Viscosity of, A Suggested Method of Investigating, I. Masson, N. F. Gilbert, and H. Buckley, 590
Glass-blowing, Laboratory, A Handbook of, B. D. Bolas, 464
Glassware, The Annealing of, and Annealing without Pyrometers, F. Twyman, 590
Gold Coast: Department of Agriculture, H. A. Dade appointed Assistant Mycologist in the, 190; Survey Department, Report for 1920 of the, Lt.-Col. R. H. Rowe, 96
Gold-coloured Teeth of Sheep, T. Steel, 242
Goniatites, The late Lt.-Col. W. Hind, 481
Granite-Gneisses of Southern Eyre Peninsula, The, C. E. Tilley, 129
Great Bear, The Constellation of the, The Material Representation on Stone of, belonging to the Polished Stone Period, M. Baudouin, 325
Greece, Ancient, The Statecraft of, 463
Green-colouring of Surf on the Horizon, The, Dr. S. W Visser, 178
Gynecology, Dr. B. M. Anspach, 206

Hæmolytic Action of Sodium Glycocholate, E. Ponder, 485
Halley Lecturer for 1922, J. H. Jeans appointed, 134
Harvard College Observatory, Dr. H. Shapley appointed Director of the, 443
Haszing, Jan, The "Account Book" of, C. Pijper and H. Zwarenstein, 518
Hearing, The Resonance Theory of, Dr. W. Perrett, 569
Heat Conduction, A Problem in the Theory of, Dr. J. W. Nicholson, 421
Heath-fires, The Generation of, H. Bury, 83
Hedgehog, Habits of the, Miller Christy, 242
Height Record, New, Lieut. J. Macready, 190
Helianthus annuus, A Quantitative Analysis of the Growth of, Part I., F. Kidd, C. West, and G. E. Briggs, 388
Heredity, Environment, and Evolution, Prof. E. S. Goodrich, 57
Highest Inhabited House, The, W. Harcourt-Bath, 179; the Reviewer, 180
Hill Museum, Bulletin of the, No. 1, 416
Himalayas and the Gangetic Plain, The Structure of the, Criticism of R. D. Oldham's Memoir on, Lt.-Col. H. McC. Cowie, 254
Hiroshige, Y. Noguchi, 301
History and Method of Science, Studies in the, Edited by Dr. C. Singer. Vol. 1, 9
Houille Bleue," "Utilisons la, H. Lémonon, 445
Hull: Museum, Acquirement of Geological and other Specimens from the Royal Albert Museum, Windsor, 190; Museums Publications, 544
Human: and other Remains found at Middleton-on-the-Wolds, 95; Factor, The, 74
Hunter, John, The Burying-place of, 316

Hybridity and the Evolution of Species, Prof. J. P. Lotsy; The Writer of the Article, 274, 400; Prof. R. Ruggles Gates, 401; Prof. J. Bronté Gatenby, 469
Hydraulic: Power Development, T. Stevens, 443; States of Flow, C. Camichel, 325
Hydro-electric Scheme, A, of the Bradford Corporation, 580
Hydrogen: Cathodic, and Nitrogen at High Pressures, Reaction between, J. N. Pring and E. O. Ransome, 515; The Manufacture of, by the Partial Liquefaction of Water Gas, G. Claude, 325; The Spectra of, from Long Vacuum Tubes, Prof. R. W. Wood, 449; -ion Concentration: of Plant-cells, The, Dr. W. R. G. Atkins, 485; of the Soil to Plant Distribution: Relation of the, Dr. W. R. G. Atkins, 80; N. M. Comber, 147; E. A. Fisher, 306; Some Factors affecting the, Dr. W. R. G. Atkins, 485; Finger-and-Toe Disease of Turnips in relation to the, Dr. W. R. G. Atkins, 485; in relation to Animal Distribution, Dr. W. R. G. Atkins, 568
Hymenoptera, The Bionomics of Parasitism in certain, Miss M. D. Haviland, 554
Hypergamy, The Origin of, Dr. W. H. R. Rivers, 224

Ibérica, 446
Idio-ventricular Periodicity, D. H. de Souza and J. A. Hewitt, 485
Illuminating Engineering, The Elements of, A. P. Trotter, 365
Illumination: Commission, Session of the International, 195; Dr. E. P. Hyde elected President of the, 195; Recent Progress in connection with, L. Gaster, 414
Imperial: Cancer Research Fund, Seventh Scientific Report, 508; Water Power, 457
Indexing, Co-operative, of Periodical Literature, H. W. Wilson; The Writer of the Article, 43
India: Geological Survey of, Records of the. Vol. 53, part 1, 129; Mineral Production of, for the years 1914–18, Quinquennial Review of the, 343; The Rainfall of June and July and the Probable Amount during August and September, Dr. G. T. Walker, 130; Survey of, General Report of the, 1919–20, 129
Indian: Board of Scientific Advice, Activities of the, P. R. Rao, 254; Casein, Dr. A. N. Meldrum and D. M. Gangoli, 317; Land Mollusca, Lt.-Col. H. H. Godwin-Austen, 106; Dr. N. Annandale, 180, 340; Sir A. E. Shipley, 271; Science Congress, Forthcoming, 223; Silviculture, 3; Village Site and Cemetery near Madisonville, Excavation of an, E. A. Hooton and C. C. Willoughby, 252
Induced Reactions and Negative Catalysis, N. R. Dhar and N. N. Mittra, 516
Induction Coil, The Theory of the, Prof. E. Taylor-Jones, 461
Industrial: Fatigue Research Board, Work of the, D. R. Wilson, 414; Micro-biology, A Proposed National Institute of, A. Chaston Chapman, 425; Standardisation, G. W. Watson, 318
Industries Act, 1921, Safeguarding of, Prof. L. Bairstow and Major A. G. Church, 271
Industry, The Psychological Problems of, An Introduction to, F. Watts, 74
Infection: Process, The Physiology of the, Dr. W. Brown, 325; The History of the Doctrine of, Dr. C. Singer, 507
Inheritance, Mendelism, and Mutation, Sir G. Archdall Reid, 335
Inorganic Substances, Qualitative, A Text-book of, Dr. S. A. Kay, 527
Insanity and Mental Deficiency in Relation to Legal Responsibility: A Study in Psychological Jurisprudence, Dr. W. G. H. Cook, 143
Insect: Pests of Farm, Garden and Orchard, E. D. Sanderson. Second edition, revised and enlarged. Prof. L. M. Peairs, 495; -trapping Plants, Influence of, on their Insect Associates, F. M. Jones, 253
Integration in the Living Organism, Prof. W. M. Bayliss, 537
Interferometer, The Vertical, Prof. A. A. Michelson, 263
International: Commission on Chemical Elements Official Report of the, Prof. B. Brauner, 479: Illumination Commission, Session of the, 195; Dr E. P. Hyde elected President of the, 195; Meteorological Committee, 194; Physico-chemical Symbols Prof. A. Findlay, 474
Interocular Distance of Tested Individuals, Dr. J. W. French, 510
Iodine: Compound, Preparation of a New Type of, Prof. J. N. Collie and Miss A. Reilly, 417; in the Laminaria, P. Freundler and Mlles. Y. Menager and Y. Laurent, 454
Ionisation: Currents, The Measurement of, by Three-electrode Valves, J. C. M. Brentano, 532; in Moist and Dry Air, J. J. Nolan, 554
Irish Ichneumonidæ and Braconidæ, Rev. W. F. Johnson, 224; *Irish Naturalist*, Need of Support for the, 507
Iron, The Transformation of, at the Curie Point, P. Dejean, 135
Irrigation in Victoria and New South Wales, Anticipated Benefits of, E. T. Quayle, 27
Isotopes, The Separation of Chlorine into, Prof. W. D. Harkins, 209

Jamaica Earthquake Shock on November 25, 477
Japanese: Culture Pearls, Dr. H. Lyster Jameson, 528; Domestic Cattle, The Races of, K. Iguchi, 383
Jefferson Physical Laboratory and the Cruft Electrical Laboratory, Contributions from the, Vol. 14, 546
Jerusalem, the Jewish University in, The Use of Hebrew at, C. Crossland, 387
Jupiter, The Markings on, W. F. Denning, 547
Jurassic Chronology: II. Preliminary Studies, S. S. Buckman, 589

Kastle-Meyer Reagent, The, a very Sensitive Reagent for Copper, P. Thomas and G. Carpentier, 516
Kentucky Superstitions, Dr. D. L. and Lucy B. Thomas, 207
Kenya Department of Agriculture, Meteorological Records for 1920, 444
Kieselsäure und Silicate, H. le Chatelier. Berechtigte Uebersetzung von Dr. H. Finkelstein, 138
Kilimanjaro, Mount, Ascent of, by C. Gillman and P. Nason, 508
Kinema Studios, Dangerous Lights in, Interim Report on Alleged, 26
Kite Balloons, Dr. S. Brodetsky, 111
Kurrajong Seeds, Chemistry of, J. K. Taylor, 518

Laboratories: Their Planning and Fittings, A. E. Munby, 140
Laboratory Designs, C. E. Browne, 140
Labour, Capital, and Wages, W. L. Hichens, 58
Lafayette Super-high Power Radio Station, The, Commander S. C. Hooper, 316
Lake District, The Lead and Zinc Ores of the, T. Eastwood, 445
Land: and Freshwater Mollusca of the British Isles, Monograph of the, J. W. Taylor, 578; Connections between the other Continents and South Africa in the Past, Dr. A. L. du Toit, 551; Drainage, Text-book of, Prof. J. A. Jeffery, 7; The, and its Problems, C. Turnor, 301
Landwirtschaft mit Einschluss der Forst- und Teichwirtschaft, der Tier-Pathologie und -Medizin, Zentralblatt für die gesamte, Erster Band, 270
Langley Flying Machine, The, 297
Language, International, Two Pamphlets on, 386
Latvia, the University of, Appeal for English Books for, 483
Lead: Effect of Increasing Proportions of, upon the Pro-

perties of Admiralty Gun-metal, etc., R. T. Rolfe, 197; Isotopes, The Spectra of, Prof. T. R. Merton, 356; Ores, T. C. F. Hall, 268; Paints, Appointment of a Committee upon, 66; Storage Batteries, Effect of Evaporation on the Efficiency of, E. J. Hamlin, 32; Storage Cells, Effect of Sunlight on, E. J. Hamlin, 32
"Leader" Cables for Aircraft, 539
League of Nations, The Constitution of the Health Committee of the, 127
Leeds University: Prospectus of Courses in, Report for 1919–20 of, 102; Gift to, by Sir Edward Allen Brotherton, 229; Lecture by Prof. Grant on Dante's Conception of History; New Education Wing opened, 355; E. C. Williams appointed Research Chemist to the Joint Benzole Research Committee, 419; Calendar for 1921–22, 420; W. E. H. Berwick appointed Reader in Mathematical Analysis in, 588
Leonardo da Vinci: MSS. relating to, Prof. de Toni, 577; The Leaves torn from the E MS. of, preserved in the Library of the French Institute, Prof. de Toni, 294
Leonid Meteor Shower, The, W. F. Denning, 417
Leptospermum flavescens (Smith), The Essential Oil of, A. R. Penfold, 518
Leucite in Agricultural Soil, Solubility of, G. De A. D'Ossat, 390
Lichens which attack Glass and their Mechanical Action on Stained Glass Windows of Churches, Miss Ethel Mellor, 517
Life: and Mind, Sesamy, 83; Are the Superior Cervical Ganglia indispensable to the Maintenance of?, S. J. Meltzer, 294; The Stream of, Prof. A. Dendy, 84
Light: in Liquids and Solids, The Molecular Scattering of, Prof. C. V. Raman, 402; in the Column of Gas in contact with the Positive Electrode, Alternation of Intensity of, Sir J. J. Thomson, 546; The Depolarisation of, by Liquids holding Crystalline Particles in Suspension, S. Procopiu, 135; The Velocity of, A Modification of the Revolving Mirror Method for Measuring, Prof. A. A. Michelson, 263; The Wave Theory of, The Present Position of, Dr. R. A. Houstoun, 13, 61
Lighting of Factories and Workshops (Report of the Departmental Committee), 132
Lights on Vehicles, Departmental Committee on, Third Interim Report of the, 316
Limnaea Peregra, Sinistral, Prof. A. E. Boycott, 403
Linear Orthogonal Transformation, The Simplest Mode of representing a Continuous, R. A. P. Rogers, 554
Liquid Air Explosives, 344
Liverpool: and Manchester Railway, The, C. F. Dendy-Marshall, 446; Marine Biology Committee: Memoirs on Typical British Marine Plants and Animals, No. 24, Aplysia, Nellie B. Eales, 398; University, Bequest to, by R. Braithwaite, 262
Living Organism, The Laboratory of the, Dr. M. O. Forster (Presidential Address to the Chemistry Section of the British Association), 57, 243
Lizards, Behaviour in, E. L. Gill, 179
Llanwrtyd (Brecon), The Igneous and Associated Rocks of, 2 parts, L. D. Stamp and S. W. Wooldridge, 453
Lockyer Observatory, The Norman, Prof. H. H. Turner, 148
London: and Home Counties District, Electricity Supply in, Proposed Reorganisation of the, 542; Air, Sir Napier Shaw, 166; Mathematical Society, Election of Officers and Council of the, 414; University College: A. E. Webb appointed Senior Assistant in the Department of Civil and Mechanical Engineering of, 166; The New Chemistry Laboratories to be named after Sir William Ramsay, 419; Calendar for 1921–22, 452; University: Site, 233; The Bloomsbury Site, 292; Appointments at; The Drapers' Company's Grant to the Department of Applied Statistics and Eugenics; Dr. C. Bolton awarded the William Julius Mickle Fellowship; Conferment of Doctorates, 293; The Title of Professor of Logic and Scientific Method conferred upon Dr. A. Wolf, 451; Appointments in, 552; Conferment of Doctorates, 553; Elections to Scholarships, 588
Lower Carboniferous Rocks of West Cumberland, The, K. W. Earle, 485
Lumbricus terrestris, L., Müll., Penial and Genital Setæ of, Dr. J. Stephenson, 337
Lunar Eclipse of October 16, The, 226, 256

Maag Gearing, The, Eng.-Lt.-Comdr. L. J. le Mesurier, 479
Macedonia, A Journey through, S. Casson, 584
Mackie Ethnological Expedition to Uganda, The, Rev. J. Roscoe, 583
Madras, Flora of the Presidency of, J. S. Gamble. Part 4, Rubiaceae to Ebenaceae, 464
"Madruckverfahren," The, Process for the Improvement of Peat, 445
Magnesium Spectrum, The *rôle* of Electrical Actions in the Emission and Appearance of Certain Types of Lines of the, A. de Gramont and G. A. Hemsalech, 230
Magnetic: Declination at Different British Stations, Simultaneous Values of, Dr. C. Chree, 510; Disturbances, A Special Form of, L. Steiner, 446; Electron, The, Prof. A. H. Compton, 97
Malaria be transmitted directly by Anopheles?, Can, B. Grassi, 389
Males and Females in the Nests of the Field-ant (*Formica pratensis*) and the Tawny Ant of the Upper Jura (*F. rufa*), E. L. Bouvier and R. Roidor, 294
Malta, The Pottery Industry of, Buxton and Hort, 129
Mammalian Nerve-muscle and Reflex Preparations, Effects of Constant Galvanic Currents upon the, K. Sassa, 485
Mammals, British, A. Thorburn (in two vols.). Vol. 2, 364
Manchester: Literary and Philosophical Society: Dr. H. F. Coward elected Chairman of the Chemical Section of the; Prof. H. Lamb, Sir Ernest Rutherford, Sir Arthur Schuster, and Prof. G. Elliot Smith elected Honorary Members of the, 477; Municipal College of Technology, Prospectus of University Courses, 134; Museum: Centenary of the, 383; Growth of the, T. A. Coward, 479; University: Appointments in, 262; Prof. F. E. Weiss appointed Pro-Vice-Chancellor; Resignation of P. A. Cooper, Assistant Lecturer in Physics; C. G. Core and Miss Lucy Higginbotham re-appointed Schunk Research Assistants, 323; Gift by Lewis's, Ltd., for Scholarships; R. W. Palmer appointed Senior Lecturer in Geology; S. Wyatt Special Lecturer in Psychology, 386; Unveiling of the Memorial to the late H. G. J. Moseley, 483; Impending Retirement of Prof. H. B. Dixon, 514; Appointments in, 553
Manganese in the Organisms of the Higher Plants, The Distribution of, G. Bertrand and Mme. M. Rosenblatt, 517
Mangrove and Saltmarsh Vegetation near Sydney, with Special Reference to Cabbage Tree Creek, Port Hacking, Marjorie I. Collins, 517
Manitoba, Damage from Beavers in, 383
Map, 1:1,000,000, Present Position of the, Lt.-Col. H. S. Winterbotham, 165
Mapping from the Air, Experimental Work on, Prof. B. M. Jones, 544
Marble, The Corrosive Action of Plant Roots on, E. Chemin, 486
Marine Biological Excursion to Karachi during December, 1920, and January, 1921, General Account of a, G. Matthai, 591
Mars, Observations of, at Flagstaff, G. H. Hamilton, 447
Massachusetts Institute of Technology, Bequest to the, by F. A. Foster, 102; Dr. E. Thomson appointed Acting Head of the, 508
Materialism: Metaphysics and, Prof. H. Wildon Carr, 247, 400, 467; Dr. Norman R. Campbell, 399, 569; Relativity and, H. Elliot, 432; Rev. Canon E. McClure, 467; Dr. H. Jeffreys, 568; S. V. Ramamurty, 569
Mathematical Thought, Currents of, 427
Mathématiciens: L'Idéal Scientifique des, dans l'Antiquité et dans les Temps Modernes, Prof. P. Boutroux, 427

May-fly, A New Genus and Species of (order Plectoptera), from Tasmania, belonging to the Family Siphluridæ, Dr. R. J. Tillyard, 591
Mayen, Jan: The Geology of, J. M. Wordie; The Insect and Arachnid Fauna of, W. S. Bristowe; The Vegetation of, J. L. Chaworth-Musters, 554
McGill University: Conferment of the Degree of Doctor of Law upon Sir William J. Pope, 71; Centenary of, 261
Measurement, New Units of, in France, 577
Mechanical: Engineering Education in Bengal, 323; Sciences Tripos, Papers set in the, 1912, etc., 143
Mediaeval Contributions to Modern Civilisation: A Series of Lectures delivered at King's College, University of London. Edited by Prof. F. J. C. Hearnshaw, 34
Medical Research Council, Sir F. W. Andrewes and Sir Cuthbert Wallace appointed Members of the, 190
Mediterranean City-state in Dalmatia, Dr. Marion Newbigin, 165
Medusæ, Arctic, 385
Melampyrum, Presence of a Glucoside Hydrolysable by Emulsion in Two Species of, M. Bridel and Mlle. M. Braecke, 135
Melanesian Land-tenure, Dr. W. H. R. Rivers, 354, 583
Mellon Institute of Industrial Research, Pittsburgh, E. R. Weidlein appointed Director of the, 419
Menispora microspora, n. sp., One of the Hyphomycetæ with Mesoendogenous Conidia, Dr. B. Peyronel, 390
Merchant Venturers' Technical College, Bristol, Prospectus of the, 31
Mercury: Motion of the Perihelion of, E. Grossmann, 164; The Separation of, into Isotopes, Prof. W. D. Harkins and R. S. Mulliken, 146
Merlin, The Breeding Haunts and Habits of the, W. Rowan, 478
Mermis parasitic on Ants of the Genus Lasius, W. C. Crawley and H. A. Baylis, 453
Metallic: Coloration of Chrysalids, A. Mallock, 302; Hon. H. Onslow, 366; Colouring of Beetles, A. Mallock, 432
Metallurgical Principles and Processes, Prof. C. H. Desch, 562
Metals: Institute of, The Journal of the, Vol. 25, No. 1, 1921. Edited by G. Shaw Scott, 79; The Electrolytic Etching of, F. Adcock, 198; The Micro-examination of, with Special Reference to Silver, Gold, and the Platinum Metals, G. Patchin, 453; The Physical Chemistry of the, Prof. R. Schenck. Translated and annotated by R. S. Dean, 562; The Rigidity and Viscosity of, The Effect of Temperature on, K. Iokibe and S. Sakai, 97; The Toxicity of, for Yeasts and Moulds, M. and Mme. G. Villedieu, 389
Metaphysics and Materialism, Prof. H. Wildon Carr, 247, 400; Dr. Norman R. Campbell, 399
Meteoric Display, The August, P. Meesters, 69
Meteorites, Chondrules and Chondritic Structure in, C. P. Merrill, 263
Meteorological: Committee, International, 194; Conditions and Disease, E. J. Butler, 515; Office: Annual Report of the, 479; Edinburgh, Advisory Committee for the, Meeting of the, 381
Meteorology: Calendar Dates in, J. Mascart, 28; Dynamic, Law of the Geoidal Slope and Fallacies in, Dr. C. F. Marvin, 545; in Medicine, with Special Reference to the Occurrences of Malaria in Scotland, Dr. A. Macdonald, 135
Meteors: Large, W. F. Denning, 28; September, W. F. Denning, 131; November, W. F. Denning, 319; December, W. F. Denning, 447; January, W. F. Denning, 580
Micro-barograph, A Simple, A. Wechsler, 469
Micro-biology: Industrial, 187; A Proposed National Institute of, A. Chaston Chapman, 425
Micro-organisms and Some of Their Industrial Uses, A. Chaston Chapman, 187
Microseismic Agitation, The Periodicity of the, E. Eblé, 555
Microscope: Illumination and Fatigue, H. J. Denham, 369, 496; J. E. Barnard, 468, 566; Objectives, A New Method of Testing, H. Hartridge, 421; New Universal, for Mineralogical Researches, 254
Microscopy: Critical, How to Get the Best Out of the Microscope, Dr. A. C. Coles, 39
Military Physical Test Station, Edinburgh, The, H. Briggs, 486
Milky Way, Delineations of the, Dr. F. Goos, 319
Mind and Consciousness, Prof. C. Lloyd Morgan, 60
Mineral: Chemistry, Constitution in, Magnetochemical Research on, P. Pascal, 357; Industry of India, The, Prof. H. Louis, 343; Resources of Great Britain, Special Reports on the, Vol. 17 of the, G. V. Wilson and Dr. J. S. Flett, 96; Water: A New Type of, Nitrate Waters, C. Lepierre, 389
Minerals: constituting Prehistoric Metallic Axes, A Method for the Determination of the, M. Baudouin, 422; from Leadhills, Some, W. Campbell Smith, 388
Mines, Ancient, and Megaliths in the Hyderabad State, Major L. Munn, 96
Mining Physics and Chemistry, J. W. Whitaker, 564
Minoan Bronze Statuette in the British Museum, A Remarkable, F. N. Pryce, 95
Moby-Dick or the Whale, H. Melville, with an Introduction by Viola Meynell, 39
Modern University: From a, Some Aims and Aspirations of Science, Prof. A. Smithells, 429
Molecular Structure, Dr. I. Langmuir, 325
Molecules, The Constitution of, 218; Prof. J. R. Partington, 242
Mollusca, Fossil, New Species of, W. L. May, 72
Molluscs, Sex-manifestations and Motion in, Dr. J. H. Orton, 303; G. C. Robson, 403
Money Values, The Stabilisation of, Prof. W. A. Macfadyen, 552
Monomolecular Reaction, The Dushman Equation for the Velocity of a, W. E. Garner, 211
Monotropa, The Biology of the, Constantin and Dufour, 486
Montpellier, Associations with, 381
Moon: Eclipse of the, October 16–17, Photometric Study of the, A. Danjon, 357; An Eclipse of the, The Distribution of Brightness in the Penumbra during, F. J. W. Whipple, 497; Photographic and Systematic Map of the, C. Le Morvan, 325
Motion: on a Surface for any Positional Field of Force, J. Lipka, 326; The Natural Tendency towards Symmetry of, and its Application as a Principle in Meteorology, Dr. S. Fujiwhara, 135
Motya: A Phoenician Colony in Sicily, J. I. S. Whitaker, 269
Mound-builders of Dunstable, The, Prof. G. Elliot Smith and Capt. G. Crowden, 512
Mourning Rites of Mussulmans in the Province of Asyut, Egypt, Miss W. S. Blackman, 95
Mouvement Biologique en Europe, Le, G. Bohn, 563
Museums in Germany, Organised Co-operation of, L. H. W. Klingender, 289
Music, Education in, Sir Henry Hadow, 60
Mutue Fides-Stavoren Tinfields, Dr. P. A. Wagner, 192

National: Benzole Association and the University of Leeds, Formation of a Joint Research Committee by the, 128; Physical Laboratory, Prof. G. W. O. Howe appointed Superintendent of the Electrical Department of the, 71; Union of Scientific Workers: Address to the, Prof. L. Bairstow, 380; Election of Dr. A. Griffith as President, 381
Native Problem, The, Dr. C. T. Loram, 551
Natural History Museum Staff Association, Scientific Reunion of the, 349
Nature, Knowledge of, The Limitations of the, J. Johnstone, 554
Naturforschenden Gesellschaft in Bern, Mitteilungen der, aus dem Jahre 1919, 431
Naval Architects, Institution of: Award of Scholarships to S. A. Hodges and T. A. Davies, 25; Award of Post-graduate Research Scholarships to H. W. Nicholls and W. R. Andrew, 166

Nebulæ: and Clusters, Studies of, C. Flammarion, 193; Visual and Photographic Observations of, Comparison between, G. Abetti, 390
Nebular Lines in Spectrum of R Aquarii, P. Merrill, 98
Nedbøriakttagelser i Norge, 512
Nervous System, Release of Function in the (Croonian Lecture), Dr. H. Head, 26
Newt and Slow-worm, Breeding Periods of, R. Elmhirst, 179
Newton, Alfred: Ornithologist, 333; Life of, Professor of Comparative Anatomy, Cambridge University, 1866–1907, A. F. R. Wollaston, 333
Newton Abbot, A Composite Sill at, W. G. St. John Shannon, 485
New York Aquarium, Report of the Director of the, for 1920, 509
Nickel–Aluminium–Copper Alloys, Properties of some, Prof. A. A. Read and R. H. Greaves, 197
Nickel Chloride, The Equilibrium in the Reduction of, by Hydrogen, E. Berger and G. Crut, 486
Night Sky, Light of the, Prof. C. Fabry, 319
Nitrogen: Problem, The, 439; Products Committee of the Ministry of Munitions, Statistical Supplement to the Final Report of the, 439
Nobel Prize for Chemistry for 1920, Award of the, to Prof. W. Nernst, 380
Nœggerathiopsis from the Lower Coal Measures of N.S.W., A. B. Walkom, 517
Nomenclature, Curiosities of, Rev. T. R. R. Stebbing, 340
Norfolk and Norwich Naturalists' Society, Transactions of the, Vol. ii., part 2, 545
North-East Coast Institution of Engineers and Shipbuilders, Awards of the, 317
North of Scotland College of Agriculture, Calendar of the, 196
Norwegian Meteorology, 512
Norwegischen Meteorologischen Instituts, Jahrbuch des, for 1920, 254
Nottingham, University College, J. Barr appointed Manager of the Yarn-testing Bureau at, 71
Nova Aquilæ, 384
Novelty, Dr. F. C. S. Schiller, 294
Numbers in Space, The Visualisation of, Prof. T. H. Pear, 325
Nyctalus Leisleri, Curious Flight by, A. W. Stelfox, 163

Oceanography: A Text-book of, Dr. J. T. Jenkins, 38; Edinburgh and the Rise of, Prof. W. A. Herdman (an Evening Discourse to the British Association), 308
Official Seed Testing Station, Impending Instruction at the, 420
Oil in Sussex, 288
Oils, The Volatile, E. Gildemeister and Fr. Hoffmann. Second edition by E. Gildemeister. Translated by E. Kremers. Vol. II., 138
Oleoleucites in the Liverworts carrying Leaves, Origin of the, A. Kozlowski, 199
Olympia Agricultural Co., Ltd., Research Department. First Annual Report, 1921, 549
Ophion luteus, Sir Herbert Maxwell, 339, 436; Dr. C. J. Gahan, R. Stenton, 403
Oppau: The Explosion at the Nitrogen Fixation Works, 137, 223, 278, 349, 382; The Atmospheric Wave produced by, L. Fabry, 294
Optaphé, The, J. W. Giltay, 510
Optic Axes of a Crystal, The Determination of the, from Extinction-angles, Prof. H. Hilton, 388
Optical: Glass, Prismatic Structure in, Dr. J. W. French, 567; Industries, The Development of, J. W. Atha and Co., 238; The Writer of the Article, 239; Dr. J. Weir French, 304; M. P. Swift, Prof. K. C. Browning, 305; Instruments, Geometrical Investigation of the Formation of Images in, embodying the Results of Scientific Researches conducted in German Optical Workshops. Edited by M. von Rohr. Translated by R. Kanthack 109; Society of America, Helmholtz Memorial Meeting in connection with the, 316; Wedges, 550.
Orchard and Garden," "The, 289
Ordnance Problems, The Applications of Physics to, Dr. G. F. Hull, 290
Organic: Analysis, Qualitative and Quantitative, E. De Barry Barnett and P. C. L. Thorne, 564; Chemistry, Calculations in, Prof. V. K. Bhagwat, 564
Organism, Living, Integration in the, Prof. W. M. Bayliss, 537
Orientation in Egypt, Col. H. G. Lyons, 587
Ornithology, Early Annals of, J. H. Gurney, 268
Otters, R. I. Pocock, 163
Oxford: Expedition to Spitsbergen, 1921, Ornithological Observations, Rev. F. C. R. Jourdain, 151; University: J. H. Jeans appointed Halley Lecturer for 1922, 134; Appointments in, 262
Oxidation and Oxidative Mechanisms in Living Tissues, Prof. F. G. Hopkins, 353
Oxygen, The Absorption Spectrum of, J. Duclaux and P. Jeantet, 294
Oyster: Native, Sex-change in the, W. L. Calderwood, 272; Spat (1921), An, with Mature Male Sexual Products, Dr. J. H. Orton, 500

Pacific Ocean, Stanford's New Map of the, 465
Paints, Painting, and Painters, Prof. H. E. Armstrong and C. A. Klein, 225
Palæobiological Research, Methods of, O. Abel, 578
Palæogeography, Methods of, Th. Arldt, 578
Palæolithic Painting in a Pyrenean Cave, M. Burkitt, 584
Palæontographical Society, E. T. Newton elected President of the, 576
Palæontology, Progress in, 481
Palæozoic Folding, The Late, in the Hunter River District, N.S.W., G. D. Osborne, 199
Paris: Academy of Sciences, Prize Awards of the, for 1921, 581; Ecole d'Anthropologie, P. Boncour appointed Professor of Criminal Anthropology, 324; Proposed Establishment of a Municipal Institute of Electrotherapy in, 316; Weather Statistics, 6
Pasteur, Louis: The Approaching Centenary of the Birth of, 25; The Birthplace of, Funds provided by J. D. Rockefeller for the Purchase of, 576
Pathogenic Organisms, Resistance of the Normal and Injured Plant Surface to the Entry of, J. H. Priestley, 589
Pearls: Japanese Culture, Dr. H. Lyster Jameson, 528; The Nucleus of Fine, L. Boutan, 389
Peat, The Carbonisation of, in Vertical Gas Retorts, 588
Penrose's Annual. Vol. 24 of the Process Year Book and Review of the Graphic Arts, 1922. Edited by W. Gamble, 526
Peronospora Schleideni, Unger, The Presence of Perennial Mycelium in, P. A. Murphy, 304
Peru, Along the Snow-line of, 78
Petrified Palm-stem, A, from the Tertiary Rocks of Jammu, Dr. B. Sahni, 591
Petrographic Methods and Calculations, with some Examples of Results achieved, Dr. A. Holmes, 494
Petrol prepared from Rape Oil, A. Mailhe, 326
Phacops africanus, Lake, A. R. E. Walker, 518
Pharmacognosy, The Science of, 203
Pharmakognosie, Handbuch der, Prof. A. Tschirch. Band III., 203
Phase Theory, The Principles of the, Heterogeneous Equilibria between Salts and their Aqueous Solutions, Dr. D. A. Clibbens, 171
Pheasants: A Monograph of the, W. Beebe (in four volumes). Vol. 2, 235; Natural History of, 235
"Philosophical Magazine," The, Sir Oliver Lodge, 12
Phosphorescence, The Action of the Infra-red Rays on, M. Curie, 263
Photographic Abstracts, No. 3, 162
Photographic Equipment and Methods of Work for Travellers, Capt. J. B. L. Noel, 579
Photographs of Geological Interest, Report of the British Association Committee on, 509
Photography, Aerial, and Photo-topography, L.-P. Clerc, 292

Photometer, The " Eder-Hecht," 550
Photosynthesis, Prof. E. C. C. Baly, Prof. I. M. Heilbron, and W. F. Barker, 354; and the Electronic Theory, II., Prof. H. H. Dixon and N. G. Ball, 590
Photosynthetic Processes in the Air, etc., in relation to the Origin and Continuance of Life on the Earth, Prof. B. Moore, 383
Physical Effects possibly produced by Vision observed by Dr. Russ, Dr. H. Hartridge, 22
Physical Science at the British Association, 448
Physico-chemical Symbols, International, Prof. A. Findlay, 474
Physics: A Text-book of, Edited by Prof. A. W. Duff. Fifth edition, 365; Institute of, Election of Board, 287; Problems of, Prof. O. W. Richardson (Presidential Address to the Mathematics and Physics Section of the British Association), 56, 372
Physiological Phenomenon, A Curious, F. C. Dannatt, Prof. T. Graham Brown, 529
Physiology: Human, Prof. L. Luciani (in five volumes). Vol. 5, Metabolism—Temperature—Reproduction, etc. Edited by Prof. M. S. Pembrey, 204; Practical, for Students of Medicine, Advanced Lessons in, Dr. R. Burton-Opitz, 143; The *Rôle* of, Sir Walter M. Fletcher, 59
Phytophthora infestans, The Binomics of the Conidia of, P. A. Murphy, 590
Pickering Series in O Type Stars, The, H. H. Plaskett, 209
Piezo-electricity ?, Muscular, E. W. Russell, 275; F. Buchanan, 340
Pilot-balloons: at Great Heights, the Behaviour of, N. K. Johnson, 453; The Variation of the Velocity of Ascent of, with Altitude, C. E. Brazier, 389
Piperitone, Position of the Double Linkage in, A. R. Penfold, 199
Pipettes, Note on, V. Stott, 590
Pisidium clessini in British Lochs, A. W. Stelfox, 40
Plague Eradication in India, Experiments on, Major J. C. G. Kunhardt and Asst.-Surgeon G. D. Chitre, 587
Planets, Minor, M. Michkovitch, Prof. M. Wolf, 69; E. Noteboom, K. Schütte, 256
Plankton, Illumination of, Lt.-Commdr. G. C. C. Damant, 42
Plant: Biochemistry, 364; Diseases and their Relation to Diseases in Man, Prof. V. H. Blackman, 289; Distribution, Relation of the Hydrogen-ion Concentration of the Soil to, Dr. W. R. G. Atkins, 80; N. M. Comber, 147; -organism, Functions of the, V. Grafe, 317; Products, An Introduction to the Chemistry of, Vol. 1: On the Nature and Significance of the Commoner Organic Compounds of Plants, Dr. P. Haas and T. G. Hill. Third edition, 138
Plantation Rubber Research, 35
Plants, The Theory of Descent in Relation to the Early History of, The Present Position of, Dr. D. H. Scott, 60
Platinum Metals, The, A. D. Lumb, 268
Plomb du Cantal, The, A Large Independent Volcano, P. Glangeaud, 454
Polygons to generate Diagrams of Maximum Stress, T. Alexander and J. T. Jackson, 421
de Pontécoulant Prize of the Paris Academy awarded to Dr. A. C. D. Crommelin, 223
Population Returns of Urban Areas and Towns, C. B. Fawcett, 165
Porphyry-quartz from the Esterel Mountains twinned on the Face (10$\bar{1}$2), Dr. J. Drugman, 388
Potato-juice, The Antiscorbutic Principle in, extracted in Presence of Acids, M. Bezssonoff, 135
Potatoes and Pigs with Milk as the Basis of Britain's Food Supply, Lord Bledisloe, 393
Powder, A Flashless and Smokeless, 222
Prehensility, A Factor of Gaseous Adsorption, H. Briggs, 485
Pressure on Resistance, The Effect of, P. W. Bridgman, 294
Pressures created in Insulating Fluids, The Variation with Time of the, by a Constant Electrostatic Field, L. Bouchet, 454
Priestley in America, 1794–1804, Prof. E. F. Smith, Sir T. E. Thorpe, 394
Primitive Groups, Part 1, Prof. W. A. Manning, 39
Princess Beans of Prof. Johannsen, Breeding Experiments with, Miss I. Leitch, 578
Prix le Conte, The, awarded to G. Claude and devoted by him to the Société de Secours des Amis des Sciences and the Research Laboratories of the Collège de France, 477
" Prizma " Process of Colour Cinematography, E. R. Mason-Thompson, 225
Psychiatry, The Basis of, Dr. A. C. Buckley, 362
Psychological: " As Ifs," Some, 525; Medicine, 362; Tests for Vocational Guidance, Dr. C. W. Kimmins and others, 321
Psychology: and Mystical Experience, Prof. J. Howley, 525; of Phantasy, Collected Papers on the, Dr. Constance E. Long, 525
Punjab, Canals of the, Lieut.-Col. A. O'Brien, 478
Pure: Substances, The Impurity of, Prof. F. G. Donnan, 298; Thought and the Riddle of the Universe, F. Sedlák. Vol. 1, Creation of Heaven and Earth, 9

Quanta, Escapements and, Sir Joseph Larmor, 254
Quantum, The: Faraday and, Dr. H. S. Allen, 341; Theory, Chemical Reactivity and the, Dr. E. K. Rideal, 259; C. G. Darwin and others, 449
Quartz, " Smoky," Prof. C. V. Raman, 81
Queensland: Gems presented to the Prince of Wales, The, B. Dunstan, 289; Mesozoic Insects of, No. 8. Hemiptera Homoptera (continued), Dr. R. J. Tillyard, 103
Quest, The: to carry out Meteorological Investigations, 66; Departure of the, 162; Change of Plans of the, 478

R 38, Proposed Fund for Airship Research in memory of the Loss of, 189
Radcliffe Observatory, Meteorological Observations made at the, 192
" Radiant " Spectrum, The: Prof. C. V. Raman, 12; Dr. H. Hartridge, 467; observed by Sir David Brewster, Prof. C. V. Raman, 485
Radiation: and Absoption by Atoms with Modified Systems of Extra-nuclear Electrons, Prof. J. C. McLennan, 448; and Chemical Action, T. W. J. Taylor, 210; Prof. W. C. McC. Lewis, 241
Radio-active: Elements, The Oxidising Properties of certain, P. Lemay and L. Jaloustre, 454; Emanation in the springs of Bagnoles-de-l'Orne and its Neighbourhood, A New, P. Loisel, 454, 517
Radio: Communication with Australia, 543; Elements, The Isotopy of the, Dr. M. L. Neuburger, 180; -goniometry, The Use of, in the Study of Storms and of Atmospheric " Parasite " Currents, E. Rothé, 422; -graphers, Society of, Establishment of a, 287; Messages, The Night Behaviour of the Heart-shaped Polar Diagram in connection with, G. M. Wright and S. B. Smith, 97; New York Central Station, Opening of the, 347
Radium: Equivalent, The Designation of the, N. E. Dorsey, 40; from Czecho-Slovakia, The Supply of, 287
Rain, Artificial Production of, Dr. H. Jeffreys, C. M. Hatfield, 313
Rainfall: Observations, October, 1920, to September, 1921, 318; Records at Rothamsted, W. D. Christmas, 307; Remarkable July, at Blue Hill, Mass., Dr. A. McAdie, 12
Rana fusca, Composition of the Egg of, at the Egg-laying Period, E. F. Terroine and H. Barthélémy, 294
Raninidæ, The, A Study in Carcinology, Prof. G. C. Bourne, 590

Rasmussen's Ethnological Expedition to the Canadian Arctic Archipelago, 189; Progress of the, 442
Rations, Nutritive Values of, Prof. W. H. Wilson, 508
Rayleigh Memorial, The: The Unveiling in Westminster Abbey, 471; Sir Joseph Thomson's Address, 472
Reading University College, Scheme for raising, to the Status of an Independent University, 484
Reef-coral Fauna of Carrizo Creek, California, The, T. W. Vaughan, 481
Reflection: from Cylindrical Surfaces, C. O. Bartrum, 436; "Halo" of (Semi-)Cylindrical Surfaces, J. H. Shaxby, 369
Reflex Responses to the Rhythmical Stimulation in the Frog, K. Sassa, 485
Relativity and Materialism: H. Elliot, 432; Prof. H. Wildon Carr, Rev. Canon E. McClure, 467; Dr. H. Jeffreys, 568; S. V. Ramamurty, Dr. N. R. Campbell, 569; Particles starting with the Velocity of Light, Prof. E. Kasner, 434; The Theory of: and the Experiment of M. Sagnac, P. Langevin, 422; Classical Mechanics and, P. Painlevé, 357
Religion and the New Psychology, W. S. Swisher, 525
Repeating Patterns, The Design of, P. A. MacMahon and W. P. D. MacMahon, 421
Research: Department, The, 489; Organised, The Function of the Scientist in, Prof. H. Levy, 161; Serials, Current, a Union List of, 542
"Réseau Mondial, 1910," 97
Respiration of Leaves in a Vacuum or in Atmospheres poor in Oxygen, L. Maquenne and E. Demoussy, 32
Review of Applied Entomology, The, 544

REVIEWS AND OUR BOOKSHELF.

Agriculture, Forestry, and Horticulture:

Bennett (H. H.), The Soils and Agriculture of the Southern States, 7
Boyle (Prof. J. E.), Agricultural Economics, 79
Doyle (K. D.), Agriculture and Irrigation in Continental and Tropical Climates, 7
Emerson (Dr. F. V.), Agricultural Geology, 7
Fawcett (W.), The Banana: Its Cultivation, Distribution, and Commercial Uses. Second edition, 270
Harris (Prof. F. S.), Soil Alkali: Its Origin, Nature and Treatment, 7
Jeffery (J. A.), Text-book of Land Drainage, 7
Orla-Jensen (Prof.), translated by P. S. Arup, Dairy Bacteriology, 431
Popenoe (W.), Manual of Tropical and Sub-tropical Fruits: excluding the Banana, Coconut, Pineapple, Citrus Fruits, Olive and Fig, 334
Smith (J. Warren), Agricultural Meteorology: The Effect of Weather on Crops, 300
Storm (Prof. A. V.), and Dr. K. C. Davis, How to teach Agriculture: A Book of Methods in this Subject, 334
Troup (Prof. R. S.), The Silviculture of Indian Trees, 3 vols., 3
Turnor (C.), The Land and its Problems, 301
Webster (A. D.), London Trees, 142
Weir (W. W.), Productive Soils: The Fundamentals of Successful Soil Management and Profitable Crop Production, 7
Zentralblatt für die gesamte Landwirtschaft mit Einschluss der Forst- und Teichwirtschaft, der Tier-Pathologie und -Medizin, Erster Band, 270

Anthropology and Archæology:

Ball (W. W. Rouse), String Figures. Second edition, 175
Deane (Rev. W.), Fijian Society: or, The Sociology and Psychology of the Fijians, 139
Thomas (Dr. D. L.), and Lucy B. Thomas, Kentucky Superstitions, 207
Whitaker (J. I. S.) Motya: A Phœnician Colony in Sicily, 269

Biology:

Beebe (W.), A Monograph of the Pheasants. In 4 vols. Vol. 2, 235
Bern, Naturforschenden Gesellschaft in, Mitteilungen der, aus dem Jahre 1919, 431
Bohn (G.), Le Mouvement Biologique en Europe, 563
Coles (Dr. A. C.), Critical Microscopy: How to get the best out of the Microscope, 39
Collectors, Handbook of Instructions for, Fourth edition, 112
Eales (Nellie B.), Aplysia (L.M.B.C. Memoirs, No. 24), 398
Emin Pascha, Dr., Die Tagebücher von, Band 6, Zoologische Aufzeichnungen Emin's und seine Briefe an Dr. G. Hartlaub bearbeitet von Prof. Dr. H. Schubotz, 397
Fabre (J. H.), The Story Book of the Fields, 270
Furneaux (W. S.), Countryside Rambles, 207
Gamble (J. S.), Flora of the Presidency of Madras. Part 4. Rubiaceae to Ebenaceae, 464
Gude (G. K.), The Fauna of British India, including Ceylon and Burma: Mollusca.—III. Land Operculates (Cyclophoridae, Truncatellidae, Assimineidae, Helicinidae), 106
Gurney (J. H.), Early Annals of Ornithology, 268
Haagner (A.), South African Mammals: A Short Manual for the use of Field Naturalists, Sportsmen, and Travellers, 113
Harvey (Prof. E. N.), The Nature of Animal Light, 174
Hayata (B.), Icones Plantarum Formosanarum necnon et Contributiones ad Floram Formosanam. Vol. 10, 237
Horwood (A. R.), A New British Flora: British Wild Flowers in their Natural Haunts. Vols. 3–6, 205
Jenkins (Dr. J. T.), A Text-book of Oceanography, 38
Johnson (Dr. S. C.), and W. B. Johnson, Freshwater Fishes and How to Identify Them, 79
Kerr (Prof. J. Graham), Zoology for Medical Students, 493
Lang (Dr. W. D.), Catalogue of the Fossil Bryozoa (Polyzoa) in the Department of Geology, British Museum (Natural History). The Cretaceous Bryozoa (Polyzoa). Vol. 3. The Cribrimorphs. Part i., 39
Lieske (Prof. R.), Morphologie und Biologie der Strahlenpilze (Actinomyceten), 397
Massingham (H. J.), Some Birds of the Countryside: The Art of Nature, 142
Mathews (G. M.), and T. Iredale, A Manual of the Birds of Australia. Vol. 1: Orders Casuarii to Columbae, 299
Melville (H.), Moby-Dick or the Whale, 39
Mortensen (Dr. Th.), Studies of the Development and Larval Forms of Echinoderms, 459
Petch (T.), The Diseases and Pests of the Rubber Tree, 524
Sanderson (E. D.), Insect Pests of Farm, Garden, and Orchard. Second Edition. Revised and enlarged by Prof. L. M. Peairs, 495
Skues (G. E. M.), The Way of a Trout with a Fly, and some further studies in Minor Tactics, 301
Thorburn (A.), British Mammals. In 2 vols. Vol. 2, 364
Wollaston (A. F. R.), Life of Alfred Newton, Professor of Comparative Anatomy, Cambridge University, 1866–1907, 333

Chemistry:

Barnett (E. de Barry), Anthracene and Anthraquinone, 108; and P. C. L. Thorne, Organic Analysis, Qualitative and Quantitative, 564
Bhagwat (Prof. V. K.), Calculations in Organic Chemistry, 564
Cavendish, The Scientific Papers of the Honourable Henry, F.R.S. Vol. i.: The Electrical Researches. Vol. 2: Chemical and Dynamical. Revised edition, 4:
Chatelier (H. le), Berechtigte Uebersetzung von Dr. H. Finkelstein, Kieselsäure und Silicate, 138

Chemists' Year Book, The, 1921, Edited by F. W. Atack, assisted by L. Whinyates. 2 vols., 9
Clibbens (Dr. D. A.), The Principles of the Phase Theory. Heterogeneous Equilibria between Salts and their Aqueous Solutions, 171
Fierz-David (Prof. H. E.), translated by Dr. F. A. Mason, The Fundamental Processes of Dye Chemistry, 138
Fries (Brig.-Gen. A. A.), and Major C. J. West, Chemical Warfare, 492
Fry (Prof. H. S.), The Electronic Conception of Valence and the Constitution of Benzene, 77
Gildemeister (E.), and Fr. Hoffmann. Second edition by E. Gildemeister. Translated by E. Kremers. The Volatile Oils. Vol. 2, 138
Haas (Dr. P.), and T. G. Hill, An Introduction to the Chemistry of Plant Products. Vol. 1 : On the Nature and Significance of the Commoner Organic Compounds of Plants. Third edition, 138
Kay (Dr. S. A.), A Text-book of Qualitative Analysis of Inorganic Substances, 527
Lefebure (Major V.), The Riddle of the Rhine : Chemical Strategy in Peace and War, 331
Searle (A. B.), The Clayworker's Handbook. Third Edition, 398
Smith (Prof. E. F.), Priestley in America, 1794–1804, 394
Smits (Prof. A.), Die Theorie der Allotropie, 298
Thatcher (Dr. R. W.), The Chemistry of Plant Life, 364
Whitaker (J. W.), Mining Physics and Chemistry, 564
Whitby (Dr. G. S.), Plantation Rubber and the Testing of Rubber, 35
Worden (E. C.), Technology of Cellulose Esters. In 10 vols. Vol. 1, Parts 1–5, 266

Engineering :

Andrews (S. T. G.), and S. F. Benson, The Theory and Practice of Aeroplane Design, 36
Carmina (B. M.), Aviation : Theoretico-Practical Text-book for Students, 36
Denton (F. M.), Elementary Principles of Continuous-current Armature Winding, 465
Pippard (A. J. S.), and Capt. J. L. Pritchard, Aeroplane Structures, 36
Struben (A. M. A.), Tidal Power, 564
Sumner (Capt. P. H.), The Design and Stability of Streamline Kite Balloons, with useful Tables, Aeronautical and Mechanical Formulæ, 111
Trewman (H. F.), and G. E. Condliffe, The Elements of Direct-current Electrical Engineering, 431
Trotter (A. P.), The Elements of Illuminating Engineering, 365
Wall (Dr. T. F.), Electrical Engineering, 205

Geography and Travel :

Bowman (I.), The Andes of Southern Peru : Geographical Reconnaissance along the Seventy-third Meridian, 78
Jones (L. R.), North England : An Economic Geography, 495
Marsden (E.), and T. A. Smith, Geography for Junior Classes, 527
Stanford's New Map of the Pacific Ocean, 465
Statesman's Year Book, The, 1921, edited by Sir J. Scott Keltie and Dr. M. Epstein, 142
Teichman (E.), Travels of a Consular Officer in North-west China, 234

Geology and Mineralogy :

Elles (Dr. Gertrude L.), The Study of Geological Maps, 301
Grabau (Dr. A. W.), Geology of the Non-metallic Mineral Deposits other than Silicates. Vol. 1, Principles of Salt Deposition, 112
Hall (T. C. F.), Lead Ores, 268
Holmes (Dr. A.), Petrographic Methods and Calculations, with some Examples of Results Achieved, 494
Kober (Prof. L.), Der Bau der Erde, 236
Lumb (A. D.), The Platinum Metals, 268
Reynolds (Prof. S. H.), A Geological Excursion Handbook for the Bristol District. Second edition, 10
Rumbold (W. G.), Chromium Ore, 268
Soergel (W.), Die Ursachen der diluvialen Aufschotterung und Erosion, 464

Mathematical and Physical Science :

Alt-Azimuth Tables, New, 65° N. to 65° S., 206
Arrhenius (S.), Traduction française par T. Sevrig. Le Destin des Etoiles : Etudes d'Astronomie Physique, 207
Boutroux (Prof. P.), L'Idéal Scientifique des Mathématiciens : Dans l'Antiquité et dans les Temps Modernes, 427
Case (J.), The Theory of Direct-current Dynamos and Motors, 461
Cusack (Dr. J.), The Arithmetic of the Decimal System, 174
Geometrical Investigation of the Formation of Images in Optical Instruments, embodying the Results of Scientific Researches conducted in German Optical Workshops. Edited by M. von Rohr. Translated by R. Kanthack, 109
Hudson (Prof. R. G.), Engineering Electricity, 461
Lecat (M.), Bibliographie des Séries Trigonométriques : Avec un Appendice sur le Calcul des Variations, 112
Manning (Prof. W. A.), Primitive Groups. Part I., 39
Martin (M. J.), The Electrical Transmission of Photographs, 334
Mechanical Sciences Tripos, Papers set in the, 1912, etc., 143
Paynter (J. E.), Practical Geometry for Builders and Architects, 564
Physics, A Text-book of, edited by Prof. A. W. Duff. Fifth edition, 365
Planck (Prof. Max), Vorlesungen über die Theorie der Wärmestrahlung. Vierte Auflage, 527
Rohr (Prof. M. von), Die Binokularen Instrumente : Nach Quellen und bis zum Ausgang von 1910 Bearbeitet. Zweite Auflage, 109
Schnippenkötter (Dr. J.), Der Entropologische Gottesbeweis : Die physikalische Entwicklung des Entropieprinzips, seine philosophische und apologetische Bedeutung, 527
Sôtome (K.), Annales de l'Observatoire astronomique de Tokyo. Tome 5, 4e fascicule. Studies on Astronomical Time-keepers and Time-preserving Systems, 175
Taylor-Jones (Prof. E.), The Theory of the Induction Coil, 461
Thomas (T.), Notes on Dynamics, with Examples and Experimental Work, 207
Tychonis Brahe Opera Omnia. Tomi Quinti Fasciculus Prior, 237
Vegard (L.), and O. Krogness, The Position in Space of The Aurora Polaris, from Observations made at the Haldde Observatory, 1913–14, 431

Medical Science :

Anspach (Dr. B. M.), Gynecology, 206
Buckley (Dr. A. C.), The Basis of Psychiatry, 362
Burton-Opitz (Dr. R.), Advanced Lessons in Practical Physiology for Students of Medicine, 143
Bütschli (Prof. O.), Vorlesungen über vergleichende Anatomie. 3 Lief. Sinnesorgane und Leuchtorgane, 236
Choulant (L.), and others, Translated and Edited by Dr. M. Frank. History and Bibliography of Anatomic Illustration in its Relation to Anatomic Science and the Graphic Arts, 141
Cook (Dr. W. G. H.), Insanity and Mental Deficiency in Relation to Legal Responsibility : A Study in Psychological Jurisprudence, 143
Luciani (Prof. L.), Human Physiology (in 5 volumes). Vol. 5, Metabolism—Temperature—Reproduction, etc., edited by Prof. M. S. Pembrey, 204
Osler (William), Counsels and Ideals : From the Writings of. Second edition, 430

Tschirch (Prof. A.), Handbuch der Pharmakognosie. Band III., 203
Woodhead (Sir German), and P. C. Varrier-Jones, Industrial Colonies and Village Settlements for the Consumptive, 172

Metallurgy :
Denny (C. W.), The Electro-deposition of Copper and its Industrial Applications, 564
Metals, Institute of, Journal of the, vol. 25, No. 1, 1921, edited by G. Shaw Scott, 79
Rodenhauser (W.), J. Schoenawa, and C. H. Vom Baur, translated by C. H. Vom Baur. Third edition. Electric Furnaces in the Iron and Steel Industry, 562
Schenck (Prof. R.), translated and annotated by R. S. Dean, 562

Meteorology :
Lévine (J.), Atlas Météorologique de Paris, 6
Smith (J. Warren), Agricultural Meteorology : The Effect of Weather on Crops, 300

Miscellaneous :
Barker (A. H.), Domestic Fuel Consumption, 560
Catalogue of British Scientific and Technical Books covering every branch of Science and Technology, carefully classified and indexed, A, 462
Dander (M. M.), Airman's International Dictionary : Including the Most Important Technical Terms of Aircraft Construction, English, Franch, Italian, German, 111
Edinburgh's Place in Scientific Progress, 75
MacMunn (N.), The Child's Path to Freedom, 79
Munby (A. E.), Laboratories : Their Planning and Fittings, 140
Mediæval Contributions to Modern Civilisation : A Series of Lectures delivered at King's College, University of London. Edited by Prof. F. J. C. Hearnshaw, 34
Noguchi (Y.), Hiroshinge, 301
Penrose's Annual, vol. 24 of the Process Year Book and Review of the Graphic Arts, 1922. Edited by W. Gamble, 526
Rayne (Major H.), Sun, Sand, and Somals : Leaves from the Notebook of a District Commissioner in British Somaliland, 112
Rhodes (E. C.), Smoothing (Tracts for Computers, No. 6), 495
Roberts (S. C.), A History of the Cambridge University Press, 1521–1921, 365
Science, History and Method of, Studies in the. Edited by Dr. C. Singer, vol. 2, 9
Science : The Outline of, A Plain Story Simply Told. Edited by Prof. J. Arthur Thomson, 403
Smithells (Prof. A.), From a Modern University : Some Aims and Aspirations of Science, 429
Tassy (E.), and P. Léris, Les Ressources du Travail Intellectuel en France, 270
Year-book of the Scientific and Learned Societies of Great Britain and Ireland, The. Thirty-eighth Annual Issue, 563

Philosophy and Psychology :
Aristotle, The Works of, translated into English under the editorship of W. D. Ross. Vol. 10, Politica, B. Jowett ; Oeconomica, E. S. Forster ; Atheniensium Respublica, Sir Frederic G. Kenyon, 463
Fuller (Sir Bampfylde), The Science of Ourselves (a Sequel to the " Descent of Man "), 525
Howley (Prof. J.), Psychology and Mystical Experience, 525
Long (Dr. Constance E.), Collected Papers on the Psychology of Phantasy, 525
Matthews (Rev. Prof. W. R.), Studies in Christian Philosophy, being the Boyle Lectures, 1920, 559
Sedlák (F.), Pure Thought and the Riddle of the Universe. Vol. 1, Creation of Heaven and Earth, 9
Swisher (W. S.), Religion and the New Psychology, 525
Watts (F.), An Introduction to the Psychological Problems of Industry, 74

Technology :
Bolas (B. D.), A Handbook of Laboratory Glass-blowing, 464

Rheumatic Fever, The Regional Distribution of, Dr. M. Young, 444
Rhine : The Riddle of the, Chemical Strategy in Peace and War, Major V. Lefebure, 331
Rhodes Trust Statement for 1920–21, 324
Rhodesian Skull, The, Dr. A. Smith Woodward, 413, 453, 485
Rocks, The Study of, Dr. J. W. Evans, 494
Roses, British, and Hybridity, Dr. Harrison and Miss Blackburn, and others, 99
Rotating Fluids, Experiments with, G. I. Taylor, 356
Rothamsted : Agricultural Research at, 29 ; Experimental Station, a Catalogue of Journals and Periodicals in the Library of the, Dr. E. J. Russell and Miss Mary S. Aslin, 444 ; Rainfall Records at, W. D. Christmas, 307
Rotifera of Australia, The, and their Distribution, J. Shephard, 517
Royal : Institution, Dr. N. Bohr, Dr. J. Hjort, and Prof. P. Langevin elected Honorary Members of the, 477 ; Photographic Society, The Annual Exhibition of the, 128 ; Sanitary Institute : next Congress of the, 382 ; Major-General J. E. B. Seely accepts the Presidency of the, 576 ; Society : Anniversary, Election of Officers and Council and Presentation of Medals, 476 ; High Altitude Expedition to Peru, The, 347 ; Medallists, 380 ; of Edinburgh, Election of Officers and Council, 287
Rubber : Certain Vulcanising Accelerants of, Mechanical Action of, G. Bruni and E. Romani, 389 ; Grey, Presence of Manganese in, and Cause of " Tackiness " (*peciosità*), G. Bruni and C. Pelizzola, 390 ; Industry, Institution of, Inauguration of the, 349 ; Manufacture, History of, H. Rogers, 349 ; Plant, Brown Bast and the, G. Bryce ; The Writer of the Note, 81 ; Plantation, and the Testing of Rubber, Dr. G. S. Whitby, 35 ; Tree (*Hevea braziliensis*) : Diseases of the, 524 ; the Diseases and Pests of the, T. Petch, 524
Rubidium : in the Sun, Dr. M. N. Saha, 291 ; the Induction Spectrum of, L. Dunoyer, 167
Rudder Pressures and Airship R 38, 417
Ruling Test Plates for Microscopic Objectives : Sharpness of Artificial and Natural Points, A. Mallock, 10
Rumford Fund for Research in Light and Heat, List of Awards and Grants from the, 26
Russ, Dr., The Apparatus of, Prof. C. V. Boys, 40
Russia : Scientific Workers in, Prof. V. Korenchevsky, 469 ; The " Proletarisation of Science " in, Dr. B. Sokoloff, 20 ; Prof. B. Brauner, 367

Safeguarding of Industries Act : and the German Reparation (Recovery) Act, and Research and the Teaching of Science, Marquess of Crewe and others, 380 ; Appointment of C. Atkinson as a Referee under the, 348
Salix in South Africa, The Distribution of, J. Burtt-Davy, 516
Salters' Institute of Industrial Chemistry, Award of Fellowships and Scholarships, 166
Samoa, Marine Biology of Work of the Carnegie Institution in the, F. A. Potts, 590
Santonin and Import Duty, 506
Saturn's Rings, Perturbations of, Dr. G. R. Goldsbrough, 511
Scarlet-runner Beans, Bees and, H. B. Heywood, 147
Science : and Crop Production, Dr. E. J. Russell (Farmers' Lecture of the British Association), 116 ; and the Community, 429 ; Books, List of Popular, compiled by a Committee of the Washington Academy of

Science, 484; Communism and, Dr. J. W. Mellor, 113; in Edinburgh, History of, 75; in the Middle Ages, 34; in the Service of the State, T. G. Trevor, 253; in Westminster Abbey, Eng.-Com. E. C. Smith, 437; Museum, Report of the, for 1920, 66; of Ourselves, The (a Sequel to the "Descent of Man"), Sir Bampfylde Fuller, 525; Physical, at the British Association, 448; Post-war, Some Aspects and Problems of, Pure and Applied, Sir T. Edward Thorpe, 44; The History and Method of, Studies in, edited by Dr. C. Singer. Vol. 2, 9; The Message of, Sir Richard Gregory (Presidential Address to the Conference of Delegates of Corresponding Societies of the British Association), 61, 533; The Outline of, a Plain Story Simply Told, Edited by Prof. J. Arthur Thomson, 463; The "Proletarisation" of, in Russia, Dr. B. Sokoloff, 20; Dr. H. Lyster Jameson, 147; Prof. B. Brauner, 367
Scientific: and Learned Societies of Great Britain and Ireland, Year Book of the, Thirty-eighth Annual Issue, 563; and Industrial Research, Report of the Committee of the Privy Council for, for the Year 1920–21, 489; Inference, The Fundamental Principles of, Drs. Dorothy Wrinch and H. Jeffreys, 318; Inquiry a Criminal Occupation?, Is, Prof. H. E. Armstrong, 241; Men as Citizens, Sir Richard Gregory and others, 415; Periodicals, World List of, Prof. W. W. Watts, 531; Pioneers, Calendar of, 31, 71, 103, 134, 167, 197, 230, 262, 293, 324, 356, 387, 420, 452, 484, 515, 553, 589; Eng.-Comdr. E. C. Smith, 567; Publication, Dr. W. B. Brierley, 41; C. A. Hoare, 179; Dr. F. A. Bather, J. A. H., 144; Research: Duke of York, 347; in the United States, J. W. Williamson, 29; The Maintenance of, Prof. C. S. Sherrington, 470; Society, The Functions of a, with Special Reference to Meteorology, R. H. Hooker, 135; Workers in Russia, Prof. V. Korenchevsky, 469
Scilla Cooperi, Hook. Fil., etc., The Pharmacological Action of, J. W. C. Gunn, M. Goldberg, and J. H. Ferguson, 518
Scleroscope, The Use of the, on Light Specimens of Metals, F. S. Tritton, 198
Sclerotinia causing Brown Rot of Fruits, Occurrence in N.S.W. of a, The Perfect Stage of a, T. H. Harrison, 591
Scopeloid Fish of the Genus Myctophum, A Fossil, discovered by C. Arambourg in Algeria, 576
Scottish: Fisheries, Prof. W. C. McIntosh, 228; People, The Origin of the, Sir Arthur Keith, Prof. T. H. Bryce, and others, 548
Screw Nut, A New Locking, A. Rateau, 263
Sea: Casualties and Loss of Life, Sir Westcott S. Abell, 511; Internal Movements in the, Dr. H. Pettersson, 450; The Colour of the, Prof. C. V. Raman, 367
Sedum, The Genus, as found in Cultivation, R. Lloyd Praeger, 578
Seed to the Adult Plant, Contribution of the, H. Coupin, 294
Seeds: of Forest Trees, Times of Fall of, and the Resistance of the Air, H. J. Denham, 416; The Possibility of determining the Value of, by the Biochemical Method, A. Němec and F. Duchoň, 454
Seismometric Measurements of Columns in Japan, Prof. Omori, 130
Selaginella pumila, Morphology of, Miss A. V. Duthie, 518
Sex-manifestations and Motion in Molluscs, Dr. J. H. Orton, 303; G. C. Robson, 403
Sexual Differences in Colour in the Spotted Turtle, S. F. Blake, 444
Shackleton-Rowett Oceanographic and Antarctic Expedition, The, Dr. H. R. Mill, 159
Sheffield University, Appointments in, 262
Shipbuilding Returns, The, 290
Sicily, The Phoenicians in, 269
Sidebotham Collection of Lepidoptera in the Manchester Museum, The, Dr. J. C. Melville, 478
Sigillarian Stem found in Suruga Province, A, H. Yabe and S. Endô, 481
Signal Hill, Effect of Fire on the Vegetation of, Miss M. R. Michell, 518
Silica, The Estimation of, A New Method for, M. Travers, 357
Silumin, A New Light Alloy, 510
Silviculture of Indian Trees, The, Prof. R. S. Troup, 3 vols., 3
Singapore, King Edward VII. Medical School, J. W. Scharff appointed Lecturer in Biology at, 386
Sleeping Sickness, The Marshall and Vassalls Method of Treatment of, Dr. W. Yorke, 444
Smoke: Abatement, 557; and Noxious Vapours Abatement, Committee on, Final Report, 557; Nuclei from Phosphorus, The Electrification of, J. J. Dowling and C. J. Haughey, 554; Pollution, An Automatic Recorder of, Dr. J. S. Owens, 166; -veil, The, Dr. W. L. Balls, 499
"Smoky" Quartz, Prof. C. V. Raman, 81
Smoothing. Tracts for Computers, No. 6, E. C. Rhodes, 495
Smuggling of Drugs in the Federated Malay States, 67
Snails, The Dispersal of, by Birds, Prof. T. D. A. Cockerell, 496
Snakes that Inflate, G. K. Noble, 27
Sodium Oleate in the Phenomena of Shock, A. Lumière and H. Couturier, 230
Soil: Alkali: Its Origin, Nature and Treatment, Prof. F. S. Harris, 7; and Soil Management, Dr. E. J. Russell, 7
Soils: and Agriculture of the Southern States, The, Dr. H. H. Bennett, 7; and Water Supply of the Maryut District, West of Alexandria, The, Dr. W. F. Hume and F. Hughes, 585; Productive, The Fundamentals of Successful Soil Management and Profitable Crop Production, 7
Solar Eclipse, Total, of September, 1922, Prof. Campbell, 291
South Africa: Royal Society of, Election of Officers of the, 443; Social Anthropology in, Problems of Race and Nationality, Prof. Duerden, 551; Some Aspects of Botany in, and Plant Ecology in Natal, Prof. J. W. Bews, 551; The Dragon-flies of, Dr. F. Ris, 224
South African: Association for the Advancement of Science, The: Durban Meeting, 550; The South Africa Medal and Grant presented to Sir F. Spencer Lister, 551; Dr. A. W. Rogers elected President for 1922, 552; Mammals: A Short Manual for the Use of Field Naturalists, Sportsmen, and Travellers, A. Haagner, 113; Paramphistomidæ, Fisch., Some, C. S. Grobbe laar, 518
South Australia, Local Rain-producing Influences in, E. T. Quayle, 517
South London Entomological and Natural History Society, Proceedings of the, for 1920–21, 509
South Wales Coalfield, The Geology of the, part 13: The Country Around Pembroke and Tenby, E. E. L. Dixon, 257
Southern Rhodesia, Rainfall of, A. H. Wallis, 509
Space-time Co-ordinates, A System of, J. L. Synge, 275
Speaking Kinematograph Films, 161
Spectra, Absorption, Prof. E. C. C. Baly, 311
Spectral Lines, The Decomposition of, by a Magnetic Field, Twenty-fifth Anniversary of Prof. Zeeman's Observations of, 315
Speech: in the Silent World, Sir Leslie Mackenzie, 191; through the Æther, Sir Oliver Lodge, 88
Sphenodon, Preliminary Account of the Spermatogenesis of, Dr. L. T. Hogben, 388
Spheres, the Movement of, The Resistance of the Air to, and the Rate of Ascent of Pilot Balloons, C. E. Brazier, 325
Spherical Aberration, The Physical Meaning of, L. C. Martin, 589
Spitsbergen: Depredations of Egg-collectors in, Rev. F. C. R. Jourdain, 67; The Oxford Expedition to, 1921, Ornithological Observations, Rev. F. C. R. Jourdain, 151
Sponges, Fossil, VIII., C. De Stefani, 390

Spontaneous Combustion in Coal Mines (Final Report of the Departmental Committee), 132
Spurn Point and the Lost Towns of the Humber Coast, T. Sheppard, 253
Squirrels Born Early in the Year, A. Sheals, 163
St. Andrews University: Dr. W. J. Tulloch appointed Professor of Bacteriology in, 166; H. W. Turnbull appointed Regius Professor of Mathematics, 293
St. Kitts-Nevis, J. A. Robotham appointed Assistant Agricultural Superintendent at, 190
Stanford University Publications, University Series: Mathematics and Astronomy. Vol. 1, No. 1: Primitive Groups, part 1, Prof. W. A. Manning, 39
Star: Catalogues, 417; Clusters, Magnitude in, XII., H. Shapley and Helen N. Davis, 263; Colours, Observations of, 164
Starfish, The Chemical Composition of the, G. Hinard and R. Fillon, 454
Starch, Mobile, and Geotropism, E. Zaepffel, 103
Stars: Intrinsic Brightness and the Effective "Diameters" of, C. Nordmann, 294; Morning, 226, Bright Assemblage of, W. F. Denning, 384; Variable, Observations of, W. J. Luyten, 291; Prof. V. Safarik, 131; Proper Motions of Long-period, Young, Farnsworth, and Jenkins, 351
State Aid and the Farmer, S. L. Bensusan, 416
Statesman's Year-book, 1921, The. Edited by Sir J. Scott Keltie and Dr. M. Epstein, 142
Statistics, Theoretical, The Mathematical Foundations of, R. A. Fisher, 421
Steel: Castings, Hollow Cylindrical, manufactured by the Centrifugal Process, Dr. G. K. Burgess, 69; Damascene, and Modern Tool Steel, 248; Col. N. T. Belaiew, 248; Mild, The Demagnetising Field of Cylindrical Bars of, M. Dejean, 325; Stainless, Engineering Uses of, 383
Stellar: Atmospheres, Ionisation in, Dr. M. N. Saha, 131; Distances, Magnitudes, and Movements, Dr. J. Lunt, 551; Parallax, J. Jackson, 124; System, The Dynamical Equilibrium of the, Prof. A. S. Eddington, 480; System, First Attempt at a Theory of the Structure and Motion of the, Prof. J. C. Kapteyn, 449
Stellenbosch University, P. van der Bijl appointed Professor of Phytopathology and Mycology in, 71
Strahlenpilze, Morphologie und Biologie der, (Actinomyceten), Prof. R. Lieske, 397
String Figures, W. W. Rouse Ball. Second edition, 175
Sudan: A Forthcoming Ethnographical Expedition to the, Prof. C. G. Seligman and others, 450; Spinning and Weaving in the, Mrs. I. W. Crowfoot, 67
Sulphur Suspensions, The Transmission Colours of, Prof. C. V. Raman and B. Ray, 356
Sumatra, Impending Expedition to, 128
Summer-time Agreement, 543
Sun: Observations of the, made at the Lyons Observatory, J. Guillaume, 230, 325; Sand, and Somals: Leaves from the Note-book of a District Commissioner in British Somaliland, Major H. Rayne, 112
Sunlight: The Action of, A Case for Inquiry, Dr. C. W. Saleeby, 466; Sir Oliver Lodge, 496
Sunrise: and Sunset, The Duration of, Dr. W. J. Fisher, 211; Duration of, Old Observations bearing on the, Dr. W. J. Fisher, 531
Sunset: Table for the Duration of, Dr. W. J. Fisher, 433; Sunrise and, The Duration of, Dr. W. J. Fisher, 211
Sun-spots and Weather, A. B. MacDowall, 68
Surface Tension and the Suppression of Shock by Sodium Hyposulphite, W. Kopaczewski, 103
Swanley Horticultural College, Resignation by Dr. Frances M. G. Micklethwait of the Principalship of, 229
Swedish Open-air Museums, G. R. Carline, 483
Sydney University, R. M. C. Gunn appointed Lecturer in Veterinary Anatomy and Surgery, 102
Symons Memorial Gold Medal, The, awarded to Col. H. G. Lyons, 414
Syncotylia, The Theory of, and the Case of *Streptopus amplexifolius*, P. Bugnon, 326
Syphilis: Action of Certain Bismuth Derivatives on, R. Sazerac and C. Levaditi, 555; The Treatment of, by Bismuth, L. Fournier and L. Guénot, 326

Tanganyika Territory, D. Prain appointed Senior District Officer in, 190
Tapa or Bark-cloth, The Catalogue of Specimens of, acquired by the Pennsylvania University Museum, C. J. A. Howes, 96
Tar-macadam Roads, Effect of Drainage from, on Fish-life, 382
Tasmanian Mammals, Studies in, *Zaglossus Harrissoni*, sp. nov., H. H. Scott and C. Lord, 72
Tea Industry, The, A. S. Judge, 482; J. W. McKay, 483
Tellurium Sub-bromide, A. Damiens, 294
Temple Submarine Stud Driver, The, 226
Terrestrial Magnetic Disturbances and Sun-spots, J. Evershed, 566
Thermal Stresses in Spherical Shells concentrically heated, The, C. H. Lees, 421
Thermometers, Clinical, The Testing of, by the National Physical Laboratory, The British Lampblown Scientific Glassware Manufacturers' Association, 315
Thistledown, The Flight of, Prof. Miles Walker, 242; L. F. Richardson, W. E. Lishman, 340; Prof. J. Small, 500
Thomson Effect, The, and Thermal Conduction in Metals, E. H. Hall, 326
Tibesti, Borku, Erdi, and Ennedi Regions, Map of the, 544
Tidal Power, M. Lémonon, 546; A. M. A. Struben, 564
Tides: British Research on, Dr. Doodson, 418; Some Biological Effects of the, F. W. Flattely, 318
Timgad, Excavations of, F. H. Hall, 349
Tin Plague and Scott's Antarctic Expedition, Prof. A. W. C. Menzies, 496
Tissue Metabolism, 353
Tissues, Living, The Laws of the Electrical Resistance of, M. Philippson, 231
Totemism, Sir William Ridgeway and others, 583; and Ancestral Worship, Sir W. Ridgeway, 129
Tradition, The Geographic Aspects of, Miss R. M. Fleming, 165
Travel in North-west China, 234
Trees, London, A. D. Webster, 142
Trenton Group, Fauna of the, Prof. P. E. Raymond, 481
Trigonométriques: Bibliographie des Séries, Avec un Appendice sur le calcul des Variations, M. Lecat, 112
Trilobites, The Appendages, Anatomy, and Relationships of, Prof. P. E. Raymond, 481
Tropical and Sub-tropical Fruits: Manual of, excluding the Banana, Coconut, Pineapple, Citrus Fruits, Olive and Fig, W. Popenoe, 334
Tropical College of Agriculture, A, 265
Trout with a Fly, The Way of a, and some Further Studies in Minor Tactics, G. E. M. Skues, 301
Tuberculous Antibodies, A. Calmetté, L. Nègre, and A. Boquet, 486
Turbines, Reaction, working under a Variable Load, The Yield of, M. de Sparre, 516
Turning Body, The Tangential and Radial Resistance of a, R. Serville, 135
Turtles: Carapaces of, in the Ojo Alamo Sandstone of New Mexico, C. W. Gilmore, 482; Gigantic, in an Upper Miocene Flood-deposit in the Otero de Palencia, E. H. Pacheco, 482
Tychonis Brahe Opera Omnia. Tomi Quinti Fasc. Prior, 237
Tylomyces gummiparus, n. sp., the Prototype of a new Genus of Hyphomycetes, I., Dr. J. C. Cortini, 391

Unionidæ, Fossil, in the Indian Region, E. Vredenburg and B. Prashad, 481
U.S.A.: The Bureau of Standards, War Work of, 540; The Economic Importance of the Scientific Work of the Government; Scientific and Engineering Work of the Government, Prof. E. B. Rosa, 29; The Position

of Geology and Geography in, E. B. Mathews and H. P. Little, 225
Universities' Library for Central Europe, Report of the, 196
University: and Civil Service Salaries, 222; Education: Reduction of Government Grant in aid of, 355; Resolution respecting the proposed Reduction of Grant in aid of, 452; Grants, 361; Relief for Central Europe and Russia, Sir Maurice de Bunsen, 436

V V Orionis, New Elements of Light Variation of, H. Grouiller and J. Ellsworth, 486
Valence: The Electronic Conception of, and the Constitution of Benzene, Prof. H. S. Fry, 77; Types of, Dr. I. Langmuir, 101
Valency: Bonds and the Mechanism of Organic Reactions, Prof. A. Lapworth, 584; Qualities of, Dr. R. M. Caven, 210; Dr. S. H. C. Briggs, 306
Variation and Evolution, Evidences of, as they occur in Nature, J. S. Huxley, 252
Vegetable Assimilation and Respiration, Experimental Researches on, XIV., A. J. Wilmott, 388
Venereal Disease, The Prevention of, 169
Venus and Mars, Conjunction of, W. F. Denning, 164
Verneuilina polystropha and some other Foraminifera, The Species of, E. Heron-Allen and E. Earland, 70
Vicia Faba, Production of the "marbled varieties" of, L. Blaringhem, 326
Viscosity of Normal Liquids, The Influence of Temperature on the, E. van Aubel, 32
Viscous: Fluids, The Two-dimensional Slow Motion of, Prof. L. Bairstow, Miss B. M. Cave, and Miss E. D. Lang, 356; Liquids, The Flow of, through slightly Conical Tubes, A. S. Hemmy, 388
Visibility: Methods of Improving, A. G. Lowndes, Capt. Sir David Wilson-Barker, 337; of Distant Objects, A Method of Improving, Prof. C. V. Raman, 242
Vivianite, Banded Precipitates of, in a Saskatchewan Fireclay, J. Stansfield, 589
Volta Effect in a Vacuum and in Highly Rarefied Gases, The, E. Perucca, 263
Voltage Regulator, An Automatic, F. G. H. Lewis, 388
Vowel Sounds, The Nature of, P. Edwards, Prof. E. W. Scripture, 82

Wales: The National Museum of, Department of Botany of, resignation by Dr. E. N. Miles Thomas of the Keepership of the, 442; University College of, Aberystwyth, Gift to, by Sir Garrod Thomas, 293
Walrus, Status of, The, as a Member of the British Fauna, Dr. J. Ritchie, 27
War: The Transitory Effect of, upon the Rate of Growth of Population, Prof. R. Pearl, 443; Work of the Bureau of Standards, U.S.A., 540
Wärmestrahlung, Theorie der, Vorlesungen über die, Prof. Max Planck, Vierte Auflage, 527
Water: Boiled and Unboiled, The Differentiation of, Dr. W. R. G. Atkins, 339; Power Committee of the Conjoint Board of Scientific Societies, Third and Final Report of the, 457; Development, Prof. A. H. Gibson (Presidential Address to the Engineering Section of the British Association), 59, 181
Water-clock, A Primitive, from Algeria, M. W. Hilton-Simpson, 583
Wave Theory of Light, The Present Position of the, Dr. R. A. Houstoun, 13, 61
Wave-lengths, Short, A New Radiation of, G. Reboul, 555
Waves in an Isotropic Solid, Propagation of, A. Mallock, 465
Weather Forecasting, The Possibilities of the Rocket in, R. H. Goddard, 263
Weather: Forecasts, Long-range, E. V. Newnham, 579; October, 222; November, 382
Weekly Weather Report, The, for the week ending August 27, 96
Wellesley College, Massachusetts, Bequest to, by F. A. Foster, 102
Westminster Abbey, Science in, Eng.-Com. E. C. Smith, 437
Whaling Industry, The, A. F. Bearpark, 191
Wheat, The World's, Sir James Wilson, 133
Whispering-Gallery Phenomenon at St. Paul's Cathedral, Prof. C. V. Raman and G. A. Sutherland, 42, 421
Wilson Ionisation Tracks, Some Peculiarities of the, and a Suggested Explanation, J. L. Glasson, 421
Wind, The Dynamics of, Dr. H. Jeffreys, 453
Wireless Telegraphy, Long-distance, The Coming of Age of, and some of its Scientific Problems, Prof. J. A. Fleming, 448
Wisconsin University Observatory, Dr. J. Stebbings appointed Director of the, 443
Women, Cambridge and, 292
World's Wheat Supply, The, 133

X-radiation, The Energy of, Prof. C. G. Barkla, 449
X-ray: Analysis of Adularia Felspar and Moonstone, S. Kozu and others, 352; Spectra, The Relative Positions and Intensities of Lines in, W. Duane and R. A. Patterson, 294
X-rays: Absorption of: W. E. Williams and B. L. Worsnop, 306; by Chemical Elements of High Atomic Numbers, W. Duane, H. Fricke, and W. Stenström, 326; L Series, Characteristic Absorption of, W. Duane and R. A. Patterson, 294; Pamphlet on, Kodak, Ltd., 479; Secondary, The Softening of, Prof. A. H. Compton, 366; S. J. Plimpton, 402; Dr. J. A. Gray, 435; The K Series of, W. Duane and W. Stenström, 263

Yass, N.S.W., Occurrence of Porphyritic Intrusions at C. W. Mann, 518
Yeast, The Longevity of Certain Species of, A. R. Ling and D. R. Nanji, 388
Yeasts, The Sporulation Curve of, The Stereogrammatic Interpretation of, H. Kufferath, 230

Zenith Resistances, The Zenith Manufacturing Co., 546
Zinc: Pure Rolled, Relation between Mechanical Properties and Micro-structure in, D. H. Ingall, 198; The Distribution of, in the Organism of the Fish, M. Bodansky, 389
Zinc–Copper Alloys, The Density of, T. G. Bamford, 197
"Zoological Record," The, W. L. Sclater, 436
Zoological Society of London, Monthly Report of the, Presentation of the Silver Medal to Capt. C. H. Armitage, 477
Zoology: for Medical Students, Prof. J. Graham Kerr, 493; Some Recent Advances in, and their Relation to Present-day Problems, Prof. H. B. Fantham, 551

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Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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The Census of 1921.

JUST twelve months ago (NATURE, August 26, 1920, p. 797) we directed attention to the effect of the Census Act of last year in facilitating the work of the Registrar General and his colleagues on the census, which was then appointed to be made in April of the present year, and to the value of the information that the census might be expected to afford. Effect was duly given to the provisions of the Act by an Order in Council made on December 21, 1920, fixing the date of the census for April 24; but when that day arrived the coal dispute and the strikes which were then threatened in the railway and transport industries gave rise to doubts whether the work could be successfully carried out as intended, and a further Order in Council was obtained fixing it for June 19, when the enumeration accordingly was made. It reflects great credit on the officers responsible for the work that they have been able so soon to publish a preliminary Report (Cd. 1485) containing in adequate detail the broad features that are presented by the figures. We must await the future Reports for much of the information that we referred to in our previous article as desirable, but in the meantime this preliminary Report may be consulted with interest and profit.

For obvious reasons this Report does not contain any particulars relating to Ireland. For Great Britain the total population is given as 42,767,530; an increase of 4·7 per cent. on that of the census of 1911. The total population of Great Britain at the census of 1821 was enumerated at 14,091,757, so that the population appears to have multiplied threefold in a hundred years. In the light of this fact it is not unsatisfactory to find that the increase shown by the present census is less in actual number and in percentage than that of any previous intercensal period during the centennium. A continuance of the previous rate of increase would have resulted in over-population.

The next step in the comparison, that of the relative numbers of the sexes, introduces a new element. In England and Wales, in 1921, the males are 18,082,220 and the females 19,803,022, 1095 females to 1000 males. In 1821 there were

5,850,319 males and 6,149,617 females, or 1036 to 1000 males. There has been during the hundred years an almost unvarying increase in the proportion of females to males, and at the present census it has nearly reached eleven to ten. It is interesting to observe, however, that in Scotland, on the contrary, there has been a diminution, the proportion in 1821 having been as high as 1127 to 1000, while that in 1921 is as low as 1079 to 1000, or less than that of England and Wales.

This superiority in number of the female sex does not alarm us. Too much has been made by the Press of what are somewhat discourteously called the "surplus women." The numerical preponderance of women over men was 1,322,502 in 1911, and 1,906,284 in 1921, showing an increase of 583,782; but that is not equal to the losses by death in the war, which are estimated at 627,870. Meantime the desire of women to acquire independence, to "live their own life" in industry, in the arts, and even in science, has been greatly developed, and with it has come a marked increase in the facilities for obtaining a training to fit them for it. When the results of the returns as to age and occupation have been co-ordinated and digested, much valuable information as to the social changes which have accompanied the events of the decennium under review may be expected to be derived.

We stated last year that an increase in the number of items of information demanded in a census was likely to lead to a diminution of the probability that the returns obtained would be accurate. It is satisfactory to find that the census authorities have to some extent adopted this view, and have left out of the schedule for 1921 the inquiry as to infirmities and the inquiry as to duration of existing marriages and the number of children born of such marriages, which were both included in the schedule for 1911. The first is scarcely a fair question, and the wealth of material obtained from the second has not been completely exhausted, so that it became unnecessary to add to it.

The Registrar General appears to cast a longing, lingering look behind on his two lost columns, for he directs attention to the fact that "this is the first time in the modern history of census-taking in this country that an inquiry once introduced into the schedule has been omitted therefrom on a subsequent occasion." However, he has supplied their place by two new columns, one as to the number and ages of children under sixteen, including an inquiry as to orphans, and another as to the place of work. He thinks, and we agree with him, that the limits of expansion have now been approximately reached, and we hope that in future the principle that information should be valued, not for its quantity, but for its trustworthiness, will be borne in mind.

This leads to the consideration of the important provision of section 5 of the Act of 1920 by which the Registrar General is authorised to enter into relations with other Government Departments so as to further the supply of statistical information and provide for its better co-ordination. Much appears to have been done by him already with that view, and now that the Act has established the work of taking the census upon a permanent footing, more may still be expected to be done. By this means the Census Office may face the problem presented to it of so presenting the information it acquires as to give the maximum of useful service to the nation at the minimum risk of annoyance to the individual.

In pursuance of the steps taken to procure concerted action in making the separate censuses of the Dominions and other Colonies, this preliminary Report contains a table of the population in 1921 of Great Britain, Australia, New Zealand, the Indian Empire, and the Union of South Africa, amounting in the aggregate to 370 millions.

In addition to the general results, of which we have briefly specified some of the more outstanding features, the details are given for each county, county borough, municipal borough, and urban and rural district of its population in 1911 and 1921, and of the acreage, affording material for ascertaining instructive facts relating to density of population and the changes that have taken place in the decade.

For Greater London an increase is shown during the ten years from 7,251,358 to 7,476,168, or 3 per cent., which is much less than the increase recorded at the five previous censuses. Indeed, in that portion of Greater London which comprises the Administrative County of London and the City of London, which showed a decrease of 0·3 per cent. in the census of 1911, there is a further decrease of 0·9 per cent. in that of 1921, falling from 4,521,685 to 4,483,249.

The perfection of the numerous mechanical contrivances used for the first time on the present occasion has no doubt been of much service in the preparation of the Report.

Indian Silviculture.

The Silviculture of Indian Trees. By Prof. R. S. Troup. Vol. 1, *Dilleniaceae to Leguminosae (Papilionaceae).* Pp. lviii + 336 + iii. Vol. 2, *Leguminosae (Caesalpinieae) to Verbenaceae.* Pp. xi + 337–783 + iv. Vol. 3, *Lauraceae to Coniferae.* Pp. xii + 785–1195. (Oxford: At the Clarendon Press, 1921.) 3 vols. 5*l.* 5*s.* net.

THE history of the East India Company is of interest to men of science from the evidence it affords of a sustained and enlightened desire to increase the natural knowledge of the economic vegetable resources of its territories. At times this took the form of approval of suggestions from India, as when the Board of Fort St. George was authorised in 1780 to employ a Government botanist in the Madras Presidency, or when the Council of Fort William received in 1787 "the most hearty approbation" of the Hon. Court of Directors in London for a proposal to establish a botanical garden in Bengal. At times the proposal emanated from the Hon. Court, as when in 1785 it was resolved to publish the sumptuous volumes of Roxburgh's "Plants of Coromandel," or when in 1807 the Council of Fort William was informed that the directors were of opinion that a statistical survey of the country under the immediate authority of their presidency "would be attended with much utility," and recommended "proper steps to be taken for carrying the same into execution."

In this particular instance the Hon. Court provided detailed instructions as to the nature of the survey, and nominated the surveyor to be employed. Its choice fell on Dr. F. Buchanan, who had been attached as naturalist to an embassy to Ava in 1795 and to a mission to Nepal in 1802, had been employed by the Fort William Council to make an economic survey of Chittagong in 1798, and had been deputed in 1800 by the Marquis Wellesley to carry out a statistical survey of Mysore.

So far as the forests of North-eastern India were concerned, Buchanan's orders were to assess their composition and the value of their products beyond as well as within the company's boundaries. Among the results of his work was the preparation in 1808 of a "Catalogue of Woods peculiar to Goalpara," in Assam. This, a list of ninety timber trees, was transmitted, with the corresponding timber specimens, to the Hon. Company's master-builder at Calcutta. The information as to these timbers was incorporated in 1831 in a "List of Indian Woods," based by A. Aikin upon specimens transferred for the purpose in 1828 by the Court of Directors to the Society of Arts. Such was the value of Buchanan's observations regarding the resources of this single forest district that in 1837 his catalogue was reconstructed by M'Cosh and incorporated in the "Topography of Assam" as being still "a fair statement of the timbers" of the whole of that important province.

The tradition established by the Hon. Court of Directors of the East India Company has been worthily sustained by the distinguished Secretaries of State for India in Council who since 1858 have fulfilled the duties formerly undertaken by that court. Confining our attention to the field of study first definitely opened up by Buchanan in 1808, we may note, among those works published under the authority or with the approbation of the India Office, the "Timber Trees" of Dr. E. G. Balfour, the three editions of which were issued in 1858, 1862, and 1870, and the "Manual of Indian Timbers" of Mr. J. S. Gamble, first published in 1881, and revised and re-edited in 1902.

By 1870 the economic knowledge of the products of Indian forests had attained a standard which emphasised the need for works calculated to assist the officers who controlled these forests in identifying the species which yield the timbers concerned. Between 1869 and 1874 Col. R. H. Beddome prepared a "Flora Sylvatica" for Madras; in 1874 appeared the admirable "Forest Flora of North-west and Central India," begun by Dr. J. L. Stewart and completed by Sir D. Brandis; in 1877 was issued a "Forest Flora of British Burma," written by Mr. S. Kurz; in 1878 Mr. J. S. Gamble published a "List of Trees, etc.," for the Sikkim region of the Eastern Himalaya; and in 1894 Mr. W. A. Talbot did the same service for the Presidency of Bombay. The sustained labour which work of this essential character entails was crowned by the publication in 1906 of "Indian Trees," a comprehensive treatise in which Sir D. Brandis has dealt with the woody constituents of all the Indian forests. This work, as essential an item in the equipment of every Indian forest officer as is the "Manual of Indian Timbers," belongs, like that of Mr. Gamble, to the class of books which, in addition to provoking admiration on account of their intrinsic merits, excite wonder as to how, before they appeared, it was possible to get along without them.

The Indian forester is able to handle with some confidence the timbers his forests provide. He may with some assurance rely on the identity of

the species whence these timbers are derived. Thanks to the labours of Sir W. Schlich and Mr. W. R. Fisher, whose "Manual of Forestry" was published between 1889 and 1896, he is in a position to apply the principles of forest management with success under Indian conditions. But a gap was left in his equipment. He was without a systematic guide to the life-histories of those forest essences the products of which it is his business to dispose of to the best advantage. The importance of the factors that govern reproduction and condition the growth and survival of seedlings is now as fully realised in scientific forestry as it is in scientific agriculture.

Turning to account his own long and varied Indian experience, Prof. R. S. Troup has endeavoured to fill this gap by placing at the disposal of his former colleagues a comprehensive treatise on "The Silviculture of Indian Trees," now published under the authority of the Secretary of State for India by the Clarendon Press. Modestly regarding his work as an incentive to further study rather than an exhaustive presentation of his subject, Prof. Troup has fortunately taken a broad view with regard to the species dealt with. That a difficulty should have been felt may easily be appreciated. The area administered by the Indian Forest Department is of wide extent and is diversely conditioned as regards both soil and climate. It includes dry plains, where the rainfall may be negligible, and wooded escarpments with an annual precipitation that may exceed 400 in. It contains tropical uplands well under the normal cloud canopy of the rainy season, and temperate mountain valleys swathed in mist for weeks at a time. It extends from the mangrove forests at the outfalls of Indian rivers to the upper limits of Himalayan trees. The number of arboreal species met with is necessarily great. Not all of these, however, yield useful products; many of those that do are limited in distribution or occur but sparingly, so that their timbers, though often employed locally, are little known, if known at all, in commercial circles. The decision to deal in this work with most of the species the wood of which is known to be of value will meet with the approval of all who may use it, as will the further decision to deal with the life-histories of exotics like those Australian "gums" and American "mahoganies" the cultivation of which has become definitely established in India. But in dealing with the trees thus included the author has shown a due sense of proportion, for while the accounts of elements so important as sal and teak, chir and deodar constitute veritable monographs, trees of minor consequence are discussed with commendable brevity.

The illustrations with which the work has been provided deserve especial notice. The series of coloured plates in which seeds, germinating seedlings, and young plants are displayed are of great interest and value; the remaining drawings and the photographs are well chosen, carefully reproduced, and always instructive.

Prof. Troup will doubtless prove justified in his hope that this work may induce further research in what is a fascinating and important field. Meanwhile it is possible to say that, as a complement to those of his distinguished precursors, his work is worthy of the ægis under which it has been produced, and will prove as indispensable to the Indian forest officer as that of Gamble on "Indian Timbers" and that of Brandis on "Indian Trees."

The Works of Cavendish.

The Scientific Papers of the Honourable Henry Cavendish, F.R.S. Vol. 1: *The Electrical Researches.* Edited from the published papers and the Cavendish manuscripts in the possession of his Grace the Duke of Devonshire, K.G., F.R.S., by Prof. J. Clerk Maxwell. Revised by Sir Joseph Larmor. Pp. xxviii+452. Vol. 2: *Chemical and Dynamical.* Edited from the published papers and the Cavendish manuscripts in the possession of his Grace the Duke of Devonshire, K.G., F.R.S., by Sir Edward Thorpe, with contributions by Dr. Charles Chree and others. Pp. xii+496+6 plates. (Cambridge: At the University Press, 1921.) 6*l.* net 2 vols.

THE Cambridge edition of the scientific papers of Henry Cavendish is much more than a mere reprint. In 1879 an edition of the electrical researches was published, a work to which Clerk Maxwell, the first Cavendish professor of experimental physics, devoted the last five years of his life. This long period was required because Cavendish had left behind, in addition to his papers in the Philosophical Transactions, a manuscript record of many experiments which were not published, but were sufficiently precise to prove that he was familiar with the theory of divided currents; had made a most extensive series of experiments on the conductivity of saline solutions in tubes, compared with wires of different metals; and had found out the inductive capacity of glass, resin, and wax. These manuscripts occupy 255 pages of the present edition as compared with sixty-six pages which are covered by

the two published papers on electricity. In addition, Clerk Maxwell's introduction and notes extend over more than 100 pages, and form a permanent record of his work on the manuscripts. The new edition of the electrical researches, which now forms vol. 1 of the "Scientific Papers," has been prepared by Sir Joseph Larmor, who has added a preface and a number of notes such as were needed to bring Clerk Maxwell's commentary up to date, and has made a number of improvements in the text as issued just before the death of the first editor.

The chemical and dynamical researches which form the second volume of the "Scientific Papers" are edited by Sir Edward Thorpe, and have not been issued previously. In this case the proportion of published papers is much larger, but the seventy-four pages of introduction form a masterly review of Cavendish's work as a chemist, and bring out in a remarkably clear way some of the main features of this work. Thus it appears, not only from the papers, but also from the manuscripts, to how large a degree Cavendish's experiments assumed an accurately quantitative character—even the alkalis that he used were standardised by neutralising with nitric acid and weighing the nitre which they yielded on evaporation. It was perhaps this passion for exact measurements that caused him to withhold from publication much of his experimental work, as, for instance, part 4 of his "Experiments on Factitious Air," in which he studied with much care, but without securing completely consistent measurements, the mixtures of gases (carbon monoxide and dioxide, marsh-gas, and hydrogen) produced by the destructive distillation of wood, tartar, and hartshorn.

A second feature to which the editor directs much attention is Cavendish's adhesion to the doctrine and language of the phlogiston theory. The doubt as to Cavendish's claim to the discovery of the composition of water, which is indisputable as a matter of experiment, rests mainly on the ambiguous expression of his results in the language of this theory. Those who have read his published papers are familiar with the necessity that exists for thinking of oxidation when Cavendish speaks of dephlogistication; but it is perhaps fortunate that the letter written by Cavendish to Blagden on the receipt of a copy of Lavoisier's "Nomenclature Chymique" was not published at the time, for it contains a strong protest against naming substances in terms of a theory, a protest which is scarcely justified from one whose writings, almost from beginning to end, require to be translated mentally, in order to disentangle them from the language of an obsolete theory in terms of which they are expressed.

The unpublished manuscripts on chemistry contain a considerable amount of valuable material. An unpublished paper describing Cavendish's "Experiments on Arsenic" (probably made in 1767) shows that he was familiar with the oxidation by nitric acid of white arsenic to arsenic acid, and that he had fully investigated the properties of the latter acid and its salts, probably ten years before Scheele. He considers, however, that "the only difference between plain arsenic and the arsenical acid is that the latter is more thoroughly deprived of its phlogiston than the former," and does not recognise the significance of the gain in weight which he had found to accompany the oxidation. His unpublished "Experiments on Tartar" also compete in interest with the paper in which Scheele, in 1769, first described the properties of the acid; but it is not clear whether Cavendish's two series of experiments preceded and followed the publication of this paper, or were all carried out independently of it. A note on the "Solution of Metals in Acids," which was withheld from the first paper on "Factitious Air," explains the action of nitric acid in dissolving metals as due to the "affinity of the phlogiston of the metals to the nitrous acid," giving rise to vapours "composed of the nitrous acid united to the phlogiston of the metal." The influence of phlogiston also appears in Cavendish's incredulity when he found that charcoal deflagrated with nitre showed a loss in weight which was smaller than the loss of weight when the carbonate of the ash was decomposed by acids—from his point of view the "fixed air" in the ash was wholly derived from the charcoal by a mere process of dephlogistication, and the oxygen contributed by the nitre was not allowed for; in the same way, it may be noted, Lavoisier at first tried to recover oxygen from mercuric oxide by heating it with charcoal—a phlogisticating agent the material character of which was realised only when at last the theory of phlogiston was obliged to release its strangle-hold on the growing science of chemistry.

One other service which the editor of the chemical and dynamical researches has rendered to the vindication of the merits of Cavendish as a pioneer worker in science is seen in his detailed study of the experiments on the freezing of aqueous acids, which Cavendish carried out with the co-operation of Mr. John McNab, of Albany Fort, Hudson Bay, as described in the Philosophical Transactions of 1788. Sir Edward Thorpe is able to show, by a comparison with

modern measurements, that Cavendish and his colleague froze out and separated the hydrates $HNO_3,3H_2O$, $HNO_3,2H_2O$, and H_2SO_4,H_2O; determined accurately their compositions and melting points, as well as those of the eutectic mixtures in which these hydrates are concerned; and secured data which can be plotted with remarkable accuracy on a modern freezing-point diagram.

In addition to the chemical papers and manuscripts, the second volume of the "Scientific Papers" includes reprints of the remaining papers, of which the most important describes the well-known "Experiments to Determine the Density of the Earth." In dealing with this section of Cavendish's work the editor has obtained contributions from Dr. Chree, who writes a note on the determination of the height of the aurora, and gives an account of Cavendish's magnetic work; from the Astronomer Royal, who writes on Cavendish's astronomical manuscripts; from Sir Archibald Geikie, who writes on Cavendish as a geologist; and from Sir Joseph Larmor, who adds a note to a manuscript on "The Refraction on a Mountain Slope," and gives an account of Cavendish's mathematical and dynamical manuscripts.

It is a tribute to the work which has been expended on these two volumes that only sixty-six out of 452 pages of the first volume, and 220 out of 496 pages of the second, are occupied by reprints of the papers from the Philosophical Transactions. The Cambridge University Press has produced a worthy memorial of the work of one of the most distinguished of Cambridge men, and no student of the history of science in England can afford to ignore or to neglect these volumes. T. M. L.

Paris Weather Statistics.

Atlas Météorologique de Paris. By Joseph Lévine. Pp. vi+83+9 plates. (Paris: Gauthier-Villars et Cie, 1921.) 20 francs.

MUCH more will be found in this atlas than is to be inferred from the title. The author promises to set out graphically the annual values of meteorological elements for Paris from 1700 to 1920, with monthly values from 1761. This is shown in a series of plates. He also gives complete monthly and annual tables for several elements from 1874 to 1920, with a column of annual departures from average, and of variations from year to year. The wind tables are not so full, as they date back only to 1890, and some of the other tables do not begin until 1876 or 1878. In addition, there is a table of extreme barometer readings from 1809 to 1919 for each month and for the year, and of highest and lowest mean monthly and annual readings from 1757 to 1919. The highest recorded barometer reading at an altitude of 67 m. was 781·2 mm. in February, 1821, and the lowest 713·5 mm. in December of the same year. During the period from 1878, of which fuller details are given, the highest readings were 782·4 mm. on January 16, 1905, and 782·3 mm. on January 17, 1882, at an altitude of 50·3 m. (corresponding to 780·7 mm. at an altitude of 67 m.), and the lowest 718·1 mm. on January 10, 1916. It is to be remarked that at Greenwich, in the same period, the highest readings—782 mm.—were recorded on January 17, 1882, and January 29, 1905. The latter was nearly a fortnight later than the Paris maximum, though the former was on the same day, indicating a very extensive anticyclone, with possibly an even higher reading at some intermediate point. Naturally, no such accordance can be expected in the minimum readings.

The highest shade temperature at Paris was 38·4° C. (101·1° F.) on July 20, 1881, five days after the Greenwich reading of 97·1° F., which has been exceeded only by that of 100·0° F. on August 9, 1911, on which day the Paris reading was 97·7°. The lowest shade minimum in the same period at Paris was −25·6° C. (−14·1° F.) on January 20, 1879, about 20° F. lower than anything at Greenwich since 1841; but in spite of the greater rigour of the Paris frosts, they occur neither so early nor so late as at Greenwich. The limiting dates at Paris are October 5 and May 13; at Greenwich, September 27 and May 24. The corresponding limits for ground frost at Paris are September 13 and June 9, but the period covered by the table is only from 1902 to 1920. There are no real limits at Greenwich for ground frost, for it has been recorded during the same period in both July and August.

The mean rainfall of Paris is about an inch less than that of Greenwich. In the forty-six years of the table 28 in. was exceeded at Paris twice, and at Greenwich eight times. On the other hand, in six years at Paris, and in only two at Greenwich, did the annual total fall below 19 in.

Unfortunately, there is scarcely any information about duration of sunshine. The author remarks that the record is not homogeneous, and gives only the figures for 1919. W. W. B.

Soil and Soil Management.

(1) *Agricultural Geology*. By Dr. F. V. Emerson. Pp. xviii+319. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) 16*s*. 6*d*. net.

(2) *The Soils and Agriculture of the Southern States*. By H. H. Bennett. Pp. xviii+399 +plates. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1921.) 18*s*. net.

(3) *Productive Soils: The Fundamentals of Successful Soil Management and Profitable Crop Production*. By W. W. Weir. (Lippincott's Farm Manuals.) Pp. xvi+398. (Philadelphia and London: J. B. Lippincott Co., 1920.) 10*s*. 6*d*. net.

(4) *Soil Alkali: Its Origin, Nature and Treatment*. By Prof. F. S. Harris. (Wiley Agricultural Series.) Pp. xvi+258. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) 13*s*. 6*d*. net.

(5) *Text-book of Land Drainage*. By J. A. Jeffery. (The Rural Text-book Series.) Pp. xx +256. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1921.) 10*s*. 6*d*. net.

(6) *Agriculture and Irrigation in Continental and Tropical Climates*. By K. D. Doyle. Pp. xv +268. (London: Constable and Co., Ltd., 1921.) 19*s*. net.

THE output of books on the soil is now considerable, especially in the United States, and it is gratifying to find that the number of agricultural students is so large as to justify an array of volumes such as now exists.

(1) Prof. Emerson deals with the subject fundamental to a large part of the work—the geological processes by which the mineral particles of the soil came to have their present properties, composition, and position. It is no longer supposed that the study of soil is simply a branch of geology, because the vital part played by biological factors is fully recognised. Nevertheless the fact remains that geological factors determine the whole structure of the soil, on which its agricultural value largely depends.

The book deals exclusively with United States conditions, but it is of more than local interest. The method of handling the subject may be commended to teachers in this country who have no book on similar lines dealing with Great Britain. In particular the illustrations and the models are distinctly helpful in character.

Good use is made of the material collected by the U.S. Soil and Geological Surveys, and there are sketch maps to show the broad outlines of the soil regions and the main types of soil. One of the most important soil regions is the coastal plain, extending from New Jersey through Texas and on to the south, which consists mainly of sands or light loams. West and north of this region is the Piedmont Plateau, the soils of which are in the main rather heavy. A third highly important group contains the glacial and loessial soils, which include much of the wheat and corn belt.

In addition to the account of soils there is a useful survey of the phosphate deposits of the States. It is not generally realised that the United States is by far the leading producer of rock phosphate, and claims to be able to maintain this position in virtue of its enormous untouched reserves. Tennessee and Florida are the most important sources.

Altogether the book is one which cannot fail to interest the teacher in this country, while the serious agricultural student will welcome it as a concise statement of the origin of the soils of the United States and will wish he knew of as good an account of British soils.

(2) Dr. Bennett starts where Prof. Emerson leaves off, and, assuming the soils already formed, proceeds to describe them in detail and to show what agricultural systems have grown up on them. As an illustration: the coastal plains soil mentioned above is here subdivided into eighteen divisions, of which by far the largest is the Norfolk soil. General farming predominates over the whole area, the particular crops being determined by the climate, which varies from subtropical to moderate conditions not far removed from our own. The main crops, however, are cotton, maize, and tobacco; about 70 per cent. of the United States cotton is produced on these soils. There are also many specialised areas and instances of crops or products which, at first subsidiary, have gradually assumed more and more importance, until finally they dominate a district or formation. The data are well collected, and there are many tables of statistics, both in the main part of the book and in the appendix, which the reader will not easily find elsewhere. There are numerous illustrations of normal agricultural practices and novel features which possess sufficient interest to justify special description.

We know of no better account of the soil and agriculture of the Southern States, and, as in the case of Prof. Emerson's work, the British teacher will certainly wish he had as good an account of the uses to which British soils are put.

(3) Prof. Weir's book deals with the subject of

soil generally, not with the soils of a particular region. It is written for the practical agriculturist and for the student who wishes to farm rather than for the man who desires to become a soil expert, and the illustrations and the tables are of such a kind as will appeal at once to the man interested in the business aspects of the subject. Take, for instance, Table I., which summarises a long and complex series of experiments in Ohio, or the comparison between grain-farming with and without livestock respectively shown in Table II.

TABLE I.—*Effect of Liming an Acid Soil.*

Treatment (once in 5 years).	Average value of crops per acre per rotation.		Average cost of lime and fertiliser per acre per rotation.		Net gain per acre per rotation.	
	Unlimed. Dollars.	Limed. Dollars.	Unlimed. Dollars.	Limed. Dollars.	Unlimed. Dollars.	Limed. Dollars.
No manure, no fertiliser	49.40	61.40	—	5.00	—	7.00
Manure (8 tons per acre)	78.58	94.49	16.00	21.00	14.96	25.87
Acid phosphate (320 lb. per acre)	67.80	81.80	2.60	7.60	15.20	24 20
Complete fertiliser	87.76	104.49	17.60	22.60	23.46	35.09

TABLE II.—*Grain-farming* v. *Stock-farming in maintaining Soil Fertility.*

Crops.	Average yields per acre in grain-farming.		Average yields per acre in stock-farming.	
	Grain or seed.	Hay, stover, or straw.	Grain or seed.	Hay, stover, or straw.
	Bushels.	Tons.	Bushels.	Tons.
Corn ...	58·6	None harvested	64·6	1·55
Soybeans	19·0	0·87	21·9	1·00
Wheat ...	28·7	1·32	32·4	1·55
Clover ...	Not gathered			2·23

It would be difficult to find terser and clearer illustrations of the important part played by lime and livestock as adjuncts to good farming.

There is an excellent section on ploughs and other implements, and an interesting example of a fraudulent use of soil analysis of a kind we have not met with in this country. We should not agree with the author's unqualified statement of the Law of Diminishing Returns as applied to fertilisers; recent experiments in this country indicate that the return increases at first in a greater proportion than the amount of fertiliser used; not until a certain excess is reached does the return begin to diminish.

(4) Dr. Harris's book is entirely specialised, and deals with one aspect of soil only, viz. alkali, a sufficiently important subject, however, to occupy one man's whole time and attention. He speaks with great authority; as the Director of the Utah Agricultural Experiment Station he has had unrivalled opportunities for studying the problem at first hand. By alkali is meant any soluble salt that makes the soil solution sufficiently concentrated to injure the plant; the salts include the chlorides, sulphates, carbonates, and nitrates of sodium, potassium, and magnesium, and the chloride and nitrate of calcium. In the author's view these salts arise from desiccated inland seas. Most of them are actually neutral, but the word "alkali" has so long held the field that it is not likely to be displaced. Some idea of the magnitude of the problem is conveyed by the statement that more than 9,000,000 acres (or 13 per cent.) of the irrigated land of the United States suffer from this cause. While the author devotes his attention largely to practical problems he is quite alive to the scientific interest of the matter, and he gives numerous references which will allow the student to proceed further in the inquiry.

There are useful lists of indicator plants and descriptions of some of the most typical of them. Certain of the Atriplex species are the last to abandon an alkali flat. Various methods are described by which the ill effects can be mitigated, but the only permanent cure is flooding, which, however, must be accompanied by adequate drainage or it soon makes matters worse.

(5) Prof. Jeffery, who was for long in charge of the Soil Department of the Michigan Agricultural College, and has now become Land Commissioner for one of the important States railways, has published the book on drainage for which he was known to possess considerable material. It is intended for the student, and presents the subject in a very comprehensive form. Some of the experimental demonstrations are ingenious, and many of the data will prove of interest to the teacher. In the United States, as in England, the level of the wells is falling, though usually only slightly, the minimum lowering per decade for the entire country being 0·68 ft. for dug wells and 2·17 ft. for drilled wells; the maximum recorded is 4·66 ft. for the decade. The book contains some interesting illustrations of actual drainage problems which cannot fail to help the student.

(6) Mr. Doyle's book deals with the specialised subject of irrigation in its wider aspects and regarded as the basis of prosperous farming. "The most certain road to profitable production is by permanent irrigation with good drainage, in an equable climate, free from frost. Under these circumstances much of the uncertainty of farming is eliminated and the best conditions of

growth can be secured as if in a laboratory." This thesis is developed at length, and the author does not confine himself to any one country, but ranges over much of the British Empire. The book will be found to help the agricultural student who wishes to farm in the Empire, but is not certain where to go or what sort of problems will confront him when he begins.

E. J. RUSSELL.

History and Method of Science.

Studies in the History and Method of Science. Edited by Dr. Charles Singer. Vol. 2, Pp. xxii+559+55 plates. (Oxford: At the Clarendon Press, 1921.) 48*s.* net.

IN recent years there has been a great development in the study of history as applied to science, and apart from special journals and magazines dealing generally with the history of science, there is a constant accession to scientific literature of historical treatises, essays, and biographies. The present volume is the second of a series the aim of which is to help the student to a conception of the true place of scientific discovery in the history of human thought, and by a series of special papers to show the lines along which the accumulated mass of scientific knowledge has evolved.

The scope is wide, for the volume deals with such diverse subjects as hypothesis, science and metaphysics, Aristotle and the heart, medieval astronomy, the scientific works of Galileo, Leonardo as an anatomist, Greek biology and its relation to the rise of modern biology, etc. Whether it is expedient to collect in one volume subjects differing so widely in nature may be open to argument. At the same time, so far as we can judge, all the articles are of high merit, and many of them represent the work of years or even a lifetime. There must be few people whose minds are so constituted or whose knowledge and interests are so great that they can turn from reading "Four Armenian Tracts on the Structure of the Human Body" to read with relish or profit the learned article on "Archimedes' Principle of the Balance and some Criticisms upon it"; but the object of the editor was no doubt one of instruction and an attempt to keep open the wider channels of science which are daily liable to silt up through the contracting power of extreme specialism.

Mindful of these difficulties, it would therefore be invidious to criticise each article. As the bulk of the volume applies to history in the natural sciences, it will appeal most strongly to biologists, and in this connection we may direct attention to the interesting article by E. T. Withington, "The Asclepiadæ and the Priests of Asclepius"; that by the Norwegian, H. Hopstock, on "Leonardo as Anatomist"; and the very exact and accurate article by F. J. Cole on "The History of Anatomical Injections." The editor, Dr. Singer, contributes the longest article in the book, entitled "Greek Biology and its Relation to the Rise of Modern Biology," amply, and indeed expensively, illustrated.

Altogether, the book is a credit to all those who have co-operated in its production, and considering its get-up as well as the price of everything connected with printing at the present time, its cost must be regarded as very reasonable, if not actually cheap. W. B.

Our Bookshelf.

The Chemists' Year Book, 1921. Edited by F. W. Atack, assisted by L. Whinyates. Vol. 1, pp. vi+422; vol. 2, pp. vii–viii+423–1142. (Manchester: Sherratt and Hughes, 1921.)

THE new edition of "The Chemists' Year Book" has been revised in the sections on fuels and illuminants, crystallography, and cellulose, while the section on coal-tar has been completely rewritten. There are some inaccuracies to be noticed in the section on "Notable Dates in the History of Chemistry," but the numerical data appear to have been edited carefully in accordance with recent work. The section on acid and alkali manufacture is too brief to be of much value, though in some cases in which the book has been tested it has shown itself superior to other more ambitious works. The exact meaning of "percentage" in density tables, for instance, is given in cases where other compilations are quite ambiguous.

Pure Thought and the Riddle of the Universe. By F. Sedlák. Vol. 1, *Creation of Heaven and Earth.* Pp. xv+375. (London: George Allen and Unwin, Ltd., n.d.) 18*s.* net.

THE aim of this book is praiseworthy in the highest degree. Unfortunately it cannot be said to achieve success. The author tells us that he has already published a translation of the first two volumes of Hegel's "Wissenschaft der Logik," but it had failed to arouse interest. He has therefore conceived the idea, not of paraphrasing it literally, but of presenting what he considers and accepts as its essential meaning in his own words. Where he seems to us to fail is in not understanding that Hegel, so far as he makes appeal to present students, does so in the spirit of his thought and not in the now antiquated form of its expression.

A Geological Excursion Handbook for the Bristol District. By Prof. Sidney H. Reynolds. Second edition. Pp. 224. (Bristol: J. W. Arrowsmith, Ltd.; London: Simpkin, Marshall, and Co., Ltd., 1921.) 5*s.* net.

THE second edition of this useful handbook reproduces the first in all essential features. The author is, however, well known for his untiring investigations into the geology of his district, and the recent researches of his pupils and himself have necessitated a number of minor alterations in the descriptive portion of the book.

The chief additions relate to the igneous rocks associated with the Carboniferous Limestone, and four out of five new text-figures illustrate the outcrops and exposures of these rocks at Goblin Combe and in the neighbourhood of Weston-super-Mare.

It is to be regretted that page-references are lacking, not only in the list of illustrations, but also in all the other references made to text-figures. T. F. S.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Ruling Test Plates for Microscopic Objectives: Sharpness of Artificial and Natural Points.

TEST plates for microscopic objectives should consist of alternate opaque and transparent lines approximately of the same width, and placed on a plane surface (not grooves engraved on transparent material). Considerable difficulty has been found in producing such lines when the distance between them is less than about 1/2000 in. They might be made by ruling on thin opaque films, and, so far as opacity is concerned, films of silver or other metals chemically deposited on glass would meet the case; but the intrinsic strength of these films is greater than their adherence to the glass, and the whole of the metal is torn away by the ruling point when the lines are close together. In many trials I have never succeeded in ruling on chemically deposited silver at even 2000 lines per inch. I have found, however, that films of certain aniline colours dried on glass are well adapted for the purpose, their opacity being so intense as to show a fair depth of colour even when the thickness of the film is a very small fraction of a wave-length of visible light. Their adherence also to the glass is greater than their intrinsic strength, and, so far as my experience goes, the limit to the fineness of the lines which may be ruled on them is not reached until the spacing of the lines is less than the thickness of the film.

In ruling lines on such films the load on the ruling point should be sufficient to remove the material of the film, but not to scratch the surface on which it is laid, and considering how soft the film is compared to glass or quartz, it seemed worth while to see whether a steel point might not be substituted for diamond in the ruling process.

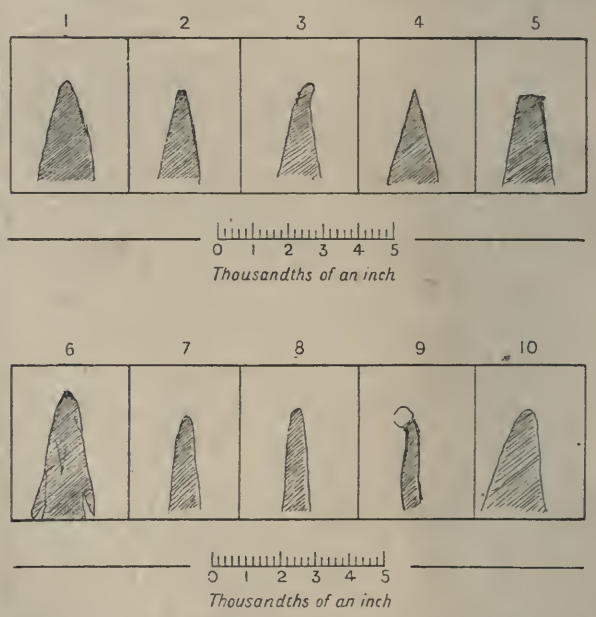
In looking into this question, one of the first things to be noticed was the extraordinarily small load which must be placed on the point. Suppose, for instance, that it is required to rule at the rate of 100,000 per inch, the area of the point in contact with the plate must not be greater than $(1/200{,}000)^2$ in., and since a grain is roughly about 1/15,700,000th of a ton, a load of 1 grain on the point will produce a pressure of more than 2500 tons per square inch. Even hard steel would not stand a hundredth of this pressure for long, and though I am not aware that any accurate measures have been made of the pressure required to scratch glass, I should expect it to be less than 10 tons per square inch.

For ruling lines at 100,000 per inch, therefore, the load on the point should be not greater than 1/200th of a grain, and the holder in which the point is carried by the ruling machine would have to be made with a very small mass, and counterbalanced.

To find out whether it was possible to grind steel points to the requisite fineness, I began by examining the points of needles in the state in which they are sold.

They varied in the degree of sharpness, but their extremities were all somewhat parabolic in section, with an average minimum radius of curvature of the order of 1/20,000 in. (Fig. 1).

On trying to secure a finer point by grinding, it was found that, using the lightest pressure which could be applied by hand to a needle mounted at the end of a light reed, the point continually broke away, leaving a rough end somewhat less than 1/10,000 in. in diameter (Fig. 2). On repeating the process with a needle which had been slightly softened, the end tended to become cylindrical, and the cylindrical part broke off when its length was about two diameters (Fig. 3). (This cylindrical end is analogous to the "wire edge" left when sharpening a rather soft knife or chisel.)

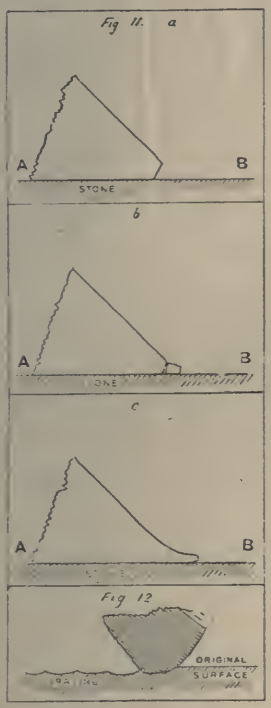


FIGS. 1 to 10.—(*Traced from photographs*) 1, needle: average point as sold. 2, needle: ground under a load of 15 grains; see broken point. 3, needle: softened to show bending under the same load. 4, needle: ground under a load of 1 grain (about). 5, needle: dropped, point downwards, on a glass plate; fall 1 in. 6, spine of cactus (Opuntia): barbs much sharper than the apex. 7, thistle spine. 8, gorse prickle. 9, stinging-hair of nettle: this is a thin-walled tube; a drop of poison is issuing from the end. 10, bramble: immature prickle; older prickles are not so sharp.

Using an unsoftened needle so mounted that very light pressure might exist between it and the grinding stone, a point was produced which appeared perfectly sharp under a microscopic power of 300 (Fig. 4). How sharp this really is is quite uncertain, for probably the same appearance would be presented whether the radius of curvature were one-half or one-hundredth of a wave-length of the light used in its examination.

I believe, however, that, short of molecular dimensions, there is no limit to the sharpness attainable if sufficiently light pressures are used in grinding.

In order to get some idea of the chance which a fine steel point would have of surviving when in use, I dropped a needle weighing about 3 grains through a distance of 1 in. on a glass surface. The result is shown in Fig. 5.



FIGS. 11, *a*, *b*, *c*, and 12.

It would seem, therefore, that though it might be just possible to rule lines separated by 1/100,000 in. with a steel point, great care would be required, especially in bringing the point into contact with the film at the beginning of each line.

What happens in the process of grinding is indicated in Fig. 11, *a*, *b*, *c*. Suppose that a truncated cone (*a*) is being ground, and that the pressure between it and the stone is at first uniformly distributed along the line AB; as grinding proceeds it is evident that the pressure near the small end will diminish, owing to the necessary bending and shear set up at that part. Continued grinding either causes the tip to break off (*b*), or forms a quasi-cylindrical end (*c*), according to the brittleness or pliability of the material. (The wire-like end (*c*) is analogous to the "wire edge" formed when grinding a slightly soft knife or chisel.)

The harder the material and the more obtuse the cone, the nearer to the geometrical apex will the break occur.

In the ground diamond points which I have examined the end is rounded, and the lines of diffraction gratings ruled by them are merely very shallow grooves, as may be seen if thin sections are made of celluloid or gelatine casts. Casts taken from a Rowland grating of about 17,000 lines per inch gave spectra nearly as brilliant as the grating itself, but the depth of the grooves was not distinguishable even when viewed with an immersion twelfth objective. I have been told that in ruling these gratings the load on the point was 3 or 4 grains, and if this is the case the whole of the ruled surface must have been sunk below that of the original level. In casts from some of my own gratings of 5000 per inch, the grooves, though shallow, could be readily distinguished. Each groove was the full 1/5000 in. across, and I know now that the load on the point was excessive (see Fig. 12).

The natural edges of splinters of diamond offer sharper points than can be attained by grinding, and I believe that the finest ruling could be made with such splinters, properly mounted, if they could be applied with a sufficiently light load.

Many orders of plants form hard points, which, according to Bentham, should be called "thorns" when developed from the wood, and "spines" or "prickles" when products of the epidermis.

These points are often said to be "as sharp as needles," and at various times I have examined a great variety of them in order to determine their real dimensions. Figs. 6–10 are traced from photographs, but only in the barbs of the spines of some cacti have I found any natural points which approached the sharpness of a needle. As a rule "thorns" are much blunter than "spines" or "prickles."

A. MALLOCK.

9 Baring Crescent, Exeter, August 16.

Biological Terminology.

I SUSPECT that there are many others of the rank and file like myself who have followed this correspondence and feel, like a man who is a bad guesser of riddles, that there is somewhere in the questions asked by Sir Archdall Reid a "catch," and cannot yet see it. Of course, he is too busy and earnest a worker in science to ask mere riddles, and many would be thankful for a concise statement of what has been gained so far. The leading biologists have held aloof lately, and the physiologists seem disinclined to answer the appeal made to them. Is this because Sir Archdall Reid has convinced both these groups, or because they are indifferent to the issues raised, or because they are waiting for them to be put explicitly and some proposals made?

Sir Archdall Reid is liberal enough to allow us to give up for the moment the familiar examples of a "head" and a "scar," and even the blacksmith's arm. The last of these is too imaginary a case to be of much use, for no one, so far as I know, has produced a series of, say, twenty generations of blacksmiths, male and female, and demonstrated the effect or non-effect of the special use of the blacksmith's muscles on those of his clerical descendant. I am sure he will allow me to bring forward a simpler and lowlier example which appears in a book written by me, and reviewed in NATURE of June 2, p. 419. It is chosen from the mode of arrangement of the hair on the ventral surface of the domestic horse's neck, and I have contended that certain patterns found here are inherited and produced by the frequently repeated stimuli of friction in draught horses due to the collar. It may, I think, be granted:—

(1) That the domestic horse is descended from a wild form of the Equidæ, and it shares with the zebra, kiang, and onager a uniform slope of hair from the lower jaw to the chest.

(2) That numerous and varied patterns are found in place of this "normal" slope in a certain large number of horses to-day, and these are attributable to the friction of the moving collar through many generations. The inference here may be wrong or right, but this does not affect the bearing of the example on Sir Archdall Reid's questions to biologists as to what they mean when they speak of "acquired characters." It is legitimate, therefore, to speak of a horse in respect of this character as "normal" or "abnormal," the latter having patterns or reversed areas of hair, the former none. The normal horse

has thus inherited the uniform slope of hair which, I believe, is common to all mammals, but at some distant period of its evolution the abnormal horse began to assume the incipient variation because its ancestors were subject to friction from a collar *sufficient to produce it*, whereas the normal horse and its ancestors were not. We may surely to-day call these patterns "acquired characters," though their initial stages were too slight to be discovered. In such an inquiry as this, if we look away from the slight initial stages and concentrate attention only on fully formed "characters," we become bemused by this unfortunate term with all its implications. How does it help our view of the matter to call both the normal and abnormal slope "acquired" because the horse inherits the potentiality of responding thus to the stimuli of friction? If we must do so, we shall have to find some fresh term for the initial stages and changes of structure. Would Semon's conception embodied in the word "engram" not suit the case? On his hypothesis "engrams" are transmitted after the operation of a sufficient number of stimuli.

Will Sir Archdall Reid then tell us what he thinks of such initial variations as the one I have chosen, and what we should call them, if not "engrams"? These considerations are apart from the complications of inheritance introduced by bisexual reproduction and its shuffling effect on variations. WALTER KIDD.

2 Suffolk Square, Cheltenham, August 19.

The "Radiant" Spectrum.

THE title refers to an interesting optical effect observed and described many years ago by Sir David Brewster (*Phil. Mag.*, September, 1867), which appears, however, never to have been satisfactorily explained. When a small brilliant source of light is viewed through a prism held in front of the eye, a remarkable appearance is noticed, represented roughly in the accompanying diagram (Fig. 1). In the continuation of the spectrum of the source, but considerably beyond its violet end, is seen a patch of light consisting of

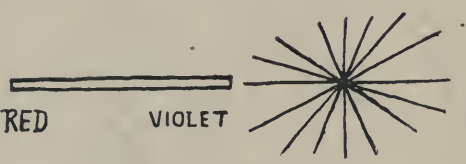


FIG. 1.

streamers radiating from a centre, as shown. A brief statement on the cause of this effect, as determined in an investigation made by me, may be of interest to readers of NATURE.

The phenomenon is due to the diffraction of light in its passage through the eye by the corneal corpuscles. Were there no prior dispersion of the light by the prism, the diffraction-halo would appear to consist of streamers surrounding the source and radiating from it directly. The effect of the dispersion on the diffraction-halo is to shift its achromatic centre towards the side of the shorter wave-lengths—in fact, to a point lying considerably beyond the violet of the spectrum of the source, exactly as observed. The streamers in the halo really consist of elongated diffraction-spectra, and the effect of the prism is to re-orient them, so that they now appear to diverge from the altered position of the achromatic centre. This explanation of Brewster's phenomenon is strikingly confirmed by the fact that very similar effects may be observed in the diffraction-halo due to a glass plate dusted with lycopodium, when held in front of the eye along with a 60° glass prism.

C. V. RAMAN.

22 Oxford Road, Putney, S.W.15.
August 12.

Remarkable July Rainfall at Blue Hill, Mass.

IN connection with the present abnormal season in North-Western Europe, it may be of interest to note that July, 1921, was not only the wettest July, but also the wettest month of any at Blue Hill since observations began thirty-six years ago. The co-ordinates of the observatory are $\phi = 42° 12' 44''$ N., and $\lambda = 71° 6' 53''$ W. Every effort has been made to preserve the integrity of the record. The total rainfall for July was 261 mm. (10·43 in.), the normal rainfall for that month being 99 mm. (3·92 in.). There were eleven rainy days, and one on which a trace of rain fell.

So far as frequency is concerned, it was a normal month.

It is difficult to characterise properly the rainfall of a summer month, owing to variability in the intensity of thunder showers. During the past month there were no remarkably heavy downpours such as distort monthly totals. Also there was on the last day of June a heavy rainfall which, if allowed for, easily makes the period one of maximum rainfall. By comparison with long-period records at New Bedford, 68 km. south (107 years), and Boston, 16 km. north (103 years), it is evident that the rainfall of July, 1921, is the heaviest in a century. With the exception of August, 1826, when at New Bedford 475 mm. was recorded, half of which, however, fell in 72 hours, the past month can be regarded as the wettest period in this section for more than a century.

Furthermore, this section of the North Atlantic coast is evidently in a period of maximum rainfall. At Blue Hill the data are as follows (in the upper row normal 35-year-period rainfalls; in lower rows the departures for 1920 and 1921):—

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Year/12.
35 years mm.	103	101	110	94	91	80	99	100	104	99	96	98	1179	98
1920	−20	+88	+25	+69	+101	+139	− 22	+25	−28	−42	+76	+23	1621	135
1921	− 8	− 1	−38	+36	+ 41	+ 30	+166	—	—	—	—	—	—	150 (?)

ALEXANDER MCADIE.

Harvard University, Blue Hill Observatory,
Readville, Mass., August 1.

The "Philosophical Magazine."

A LETTER which appears to have been widely circulated has reached me from the National Union of Scientific Workers virtually attacking the management of the *Philosophical Magazine*. Will you allow me, therefore, briefly to say that the referees mentioned on the title-page of that journal are frequently consulted, and that their services are not so nominal as the writers of the circular suppose?

I would add that, in my judgment, the *Philosophical Magazine* is well managed; that a conservative attitude towards old-established organs is wise; and that it is possible to over-organise things into lifelessness.

OLIVER LODGE.

The Present Position of the Wave Theory of Light.

By DR. R. A. HOUSTOUN.

I.

THE emission theory of light prevailed for a century after Newton's death. During this time his "Opticks" was regarded as of equal importance as his "Principia," and his emission theory as of equal value as his law of gravitation. Then, principally owing to the work of Fresnel, the emission theory was overthrown, and the wave theory established in its place. The latter in its turn has prevailed for a century, but now in certain quarters doubts are being expressed as to whether it is competent to explain the results of recent experimental work, and whether, after all, it may not be advisable to hark back to some form of emission theory, at least for certain fields of work.

There are two great differences between the situation now and as it existed a hundred years ago. Then the wave theory under Fresnel presented a clear and definite alternative to the emission theory of Newton, explaining certain decisive experiments in a simple and natural manner. The critics of the wave theory at present are not so much hostile as neutral towards it. They present no alternative to it; they admit its strong position and also admit the impossibility of Newton's emission theory in the light of the experimental work of to-day. But they direct attention to certain results which they have difficulty in reconciling with the wave theory, and hint at somehow combining the advantages of both theories.

Another difference between now and a hundred years ago is the manner in which we regard our theories. Then a theory was true or false; we were engaged in interpreting the processes of Nature which existed independently of us and outside of us, and it was necessary that the true solution should be true for all time. Nowadays we do not so much speak of the truth of a theory as of its utility, or rather the truth of a theory lies in its utility. Truth is what works. Consequently we require of a theory only that it should be true for our day and our generation. A theory works if it connects the facts together and enables us to predict new facts. We can never penetrate to the essential nature of things; we can only compare them with other things. Physical theories are metaphors. When we say that light is propagated in wave motion, we mean that it is propagated like wave motion. This change in the attitude of the physicist towards his theories had been pretty widely adopted before the results of the principle of relativity became known; the latter made the change of attitude known to the public.

The criticisms directed against the wave theory at present arise from two quarters, namely, the principle of relativity and the quantum phenomena.

The special theory of relativity requires that the mass of a system should vary with its internal energy, and that consequently radiation, including light waves, should have mass. In connection with this result a paper by Sir Joseph Thomson, entitled "Mass, Energy, and Radiation," which appeared in the *Philosophical Magazine* for June, 1920, is of the greatest interest and importance, not so much for its actual results as for the development it foreshadows. It is well known that the relativists operate with symbols and not with physical ideas; this paper is "an attempt to help those who like to supplement a purely analytical treatment of physical problems by one which enables them to visualise physical processes as the working of a model; who like, in short, to reason by means of images as well as by symbols."

The paper assumes that all mass, that of atoms as well as that of electrons, is distributed through space with a density determined by the electric field at the place where the mass is supposed to exist, and that energy of every kind, kinetic, potential, thermal, chemical, or radiant, is of one and the same type, being the kinetic energy possessed by the particles which are supposed to constitute mass. Transformation of energy is merely the flow of the mass particles from one place to another. Thus, for example, on this view, when a body gains kinetic energy, it is not because any of its mass particles are moving faster; it is because the mass of the body has been increased, and the increase in the mass implies a proportional increase in the energy.

We are not yet in a position to calculate the mass of any one of these mass particles, but at least 10^{11} are required to supply the mass of one electron. If energy is indivisible beyond a certain limit, the inverse square law of electrical attraction cannot hold over more than a certain finite distance.

The distribution of these particles and their movement from one place to another are determined by the distribution of the lines of electric force. In addition to mass particles it is assumed that there are in the universe lines of force spreading through space, the electron being at one end of a line of force and a unit of positive electricity at the other. The mass particles are concentrated in the places where the electric field is strongest. Thus, for example, if the radius of an electron is 10^{-13} cm., only one-thousandth part of its mass will be at a distance from the electron greater than 10^{-10} cm. The mass particles perform the functions of both æther and matter. Comparing the physical universe with a living organism, we may regard the mass particles as the flesh and the lines of force as the nervous system.

A light ray is consequently a jet of particles and lines of force moving sideways, the density of both varying periodically along the jet. Refraction is explained by the action of the secondary waves emitted by the electrons of the refracting medium under the stimulus of the incident wave.

The paper is noteworthy, because it points the

way we shall have to travel if the new ideas are to be translated into everyday physics in all their original force. It also prompts the query whether it is worth while.

The special theory of relativity disturbed the generally accepted views about the æther by giving equal value to co-ordinate systems moving with uniform velocity with reference to one another. We had always thought of an æther at rest, through which the sun and the planets moved, and in which our ultimate system of co-ordinate axes was at rest. The most straightforward interpretation of the special theory of relativity is to give each planet, each moving electrical charge, its own æther, and at the same time to remove all substantiality from the very great number of æthers thus postulated. The plain man wants to know, if the light comes from the sun, in which æther it travels, the sun's æther or the earth's, and if there can be wave motion without a medium. This question of the æther has been discussed so fully, and there are so many different views, that it will be passed by here with the suggestion that possibly the special theory of relativity makes too great demands when it asserts that all moving systems have equal value. The system that the inhabitants of the earth are moving with possesses a special value for them and their physical theories, because they are moving with it. We only ask of Boyle's law, for example, that it should hold for the temperatures that we can produce in the laboratory, not for impossibly high temperatures that we can never attain. In the same way it is asking too much of the wave theory of light in the form we use it that it should be equally useful (and true) for us and the possible inhabitants of Mars. It is dangerous to attribute universal validity to theories which can be tested only in a limited class of cases. Consequently the æther moving with the earth is *the* æther. Again, with reference to the apparent unsubstantiality conferred on the æther by the principle of relativity, it is forgotten that it confers some unsubstantiality on everything else as well, even the water that water waves travel in.

The general theory of relativity required that light should be deflected on passing close to the sun's surface, and, as is well known, this deflection has been verified experimentally by the observations made by the 1919 solar eclipse expeditions. On the relativity theory the space in the sun's gravitational field is non-Euclidean, and the deflection is caused simply by the properties of space. The fact of the deflection is so much simpler than the explanation that it seems probable that the physicist will ignore the latter. One wonders if it is possible to treat the deflection geometrically in a simpler manner directly from the postulate of parallels. There has been an unsuccessful attempt to explain the deflection by an emanation of matter from the sun and a consequent increase of refractive index in its neighbourhood. Newton's emission theory gives a deflection of exactly half the required amount; so also does the electromagnetic theory, if we make the unusual assumption that ordinary mass is associated with the energy of the wave, and that this mass is acted on by gravity. At present there seems no satisfactory alternative to a non-Euclidean geometrical optics and wave theory, but it is probably better to wait and in the meantime to suspend judgment.

The existence of the quantum was discovered theoretically in Planck's celebrated theory of radiation. It will be advantageous to give an account of this theory here, because an important modification of it has strengthened the view that there is nothing in the quantum phenomena inconsistent with classical mechanics or electrodynamics. This modification came too late to be noticed in certain widely read descriptions of the theory published in this country, and it has consequently received little attention.

If a hollow vessel is maintained at a uniform temperature, and radiation allowed to issue from a small hole in its side, the intensity of the radiation and the spectral distribution of its energy are independent of the material of which the vessel is made. The rays are reflected forwards and backwards inside the vessel before they issue, and any initial difference in intensity is evened out by the successive reflection. In order to derive a theoretical value for the spectral distribution of the radiation issuing from such an enclosure at different temperatures—"black" radiation, as it is called—Planck assumed that there were in the enclosure a great number of oscillators or vibrators, small Hertzian doublets, all of the same frequency, and in a state of equilibrium, radiating and absorbing energy. The total energy of the system remained constant, but the energy of the different oscillators was not the same; there were always some gaining and some losing energy. Moreover, this exchange took place solely by scattered radiation; there was nothing in the nature of corpuscular radiation or characteristic radiation taking place. The distribution of the energy among the different oscillators occurs according to the laws of probability, and by using a general definition of temperature the temperature of the system can be derived from this distribution of energy. Then the density of the radiation in the enclosure can be calculated for the particular frequency in question. In order to obtain the correct value, namely:

$$E_\lambda = \frac{c_1}{\lambda^5} \frac{1}{e^{c_2/\lambda T} - 1},$$

it was necessary to assume that the emission of energy took place discontinuously in whole multiples of the quantum, the quantum being defined by $\epsilon = h\nu$, where ν is the frequency of the radiation and h a universal constant, Planck's constant. This emission of radiation in quanta was opposed to all previous ideas.

The criticism which the experimental physicist naturally passes on Planck's proof as outlined above, and as described in his "Vorlesungen über die Theorie der Wärmestrahlung" (second edi-

tion, 1913), is that in practice the energy changes do not take place by scattered radiation alone, but also by corpuscular radiation and characteristic or fluorescent radiation. It does not seem permissible to consider scattered radiation by itself. The genesis of radiation must involve the mutual play of both corpuscular radiation and waves. When X-rays fall on a body some of the incident energy reappears as scattered radiation, some as corpuscular radiation, and some as characteristic radiation. Consequently Planck's original oscillators formed an artificial body which has no counterpart in reality. He was, of course, aware of this, for on p. 133 he states that "it does not matter whether such a body exists anywhere in Nature, it is only necessary that its existence and properties should be compatible with the laws of electrodynamics and thermodynamics."

As a result of the difficulties associated with the form of the theory described in the book referred to above Planck made an important modification of his hypothesis ("Eine veränderte Formulierung der Quantenhypothese," *Preuss. Akad. Wiss. Berlin, Ber.* 34, pp. 918–23, 1914). This paper assumes that radiation and absorption take place continuously, and that the quantum action is not between the oscillators and the radiation, but takes place between the oscillators and the free particles (molecules, ions, and electrons), which exchange energy by impacts with the oscillators. The laws of classical electrodynamics then hold good for every interchange between the oscillators and free radiation. At the same time the radiating substance becomes more like its counterpart in Nature, and the feeling of artificiality which the former theory produced is removed. Also the difficulty connected with the use of Hertz's expression for calculating the density of the radiation disappears.

(To be continued.)

The Extent of the Recent Drought.

THE recent prolonged drought in the British Isles has directed attention to an interesting aspect of meteorological science. It is natural to inquire how far the drought has been confined to our immediate neighbourhood, or how far it has been general. With the exception of Hildebrandsson's pioneer work on action centres, no systematic research dealing with the extent to which drought has affected considerable areas of the earth's surface at one time has yet been carried out. A basis for detailed study of this character will be provided by the "Réseau Mondial," published by the Meteorological Office, five annual volumes of which have now been issued. This publication gives pressure, temperature, and rainfall for about 400 stations distributed over the globe, the month being taken as a unit. In the present article it is proposed to make a preliminary survey, so far as material is already available, of the world's weather this year, particularly during the months May, June, and July. As no system of telegraphic reporting from "Réseau Mondial" stations has yet been established, we have to rely in making such a survey on the most recent monthly, weekly, or daily weather reports obtainable from the various countries, and, largely, upon general newspaper reports.

Table I. shows the percentage of normal rainfall which has fallen in various parts of the British Isles since the beginning of the year :—

TABLE I.—*Percentage of Normal Rainfall.*

1921	England and Wales.	Scotland.	Ireland.	British Isles.
January	146	168	119	145
February	15	39	51	34
March ...	101	170	129	133
April ...	59	61	46	56
May ...	79	108	90	91
June ...	17	40	24	26
July ...	Probably below 50	Rather above 100	Above 100	About 100

Table II. gives the percentage of normal rainfall for the various districts into which the British Isles are subdivided :—

TABLE II.—*Percentage of Normal Rainfall by Districts.*

	Scotland, North.	Scotland, East.	England, North-east.	England, East.	Midland Counties.	England, South-east.	Scotland, West.	England, North-west.	England, South-west.	Ireland, North.	Ireland, South.	English Channel.
January	164	162	144	107	128	118	165	174	123	132	99	95
February	64	26	16	26	15	21	37	14	9	38	60	15
March...	160	109	45	53	73	62	176	124	92	127	114	67
April ...	61	51	69	87	57	63	56	62	43	51	30	53
May ...	117	89	86	59	70	71	100	83	89	89	83	73
June ...	46	41	27	20	18	6	30	15	13	17	10	36
Average percentage February to June :—	90	63	49	49	47	45	80	60	49	64	59	49

It should be noted that Tables I. and II. are not based on identical stations.

Table I. shows that January was a month of excess rainfall in all regions. Previous to this we have to go back to July, 1920, to find another month with rainfall above normal for the whole British Isles, the percentages for August to December, 1920, varying between 68 and 96. It is evident from the table that the drought has been much more conspicuous in England and Wales than in Scotland and Ireland, where it has not been so remarkable. This is well shown in the map (Fig. 1), which has been prepared by the British Rainfall Organization. The area of greatest drought is the southern and eastern midlands, the amount of rainfall increasing outwards from this centre, particularly to the north and west. February, April, and June were the months of greatest deficiency. March, which appears to be normal (101 per cent.), was a month of drought in most places in the eastern and midland counties, but wet in the west and north-west.

The year 1887 was the driest one of the nineteenth century in the British Isles. The year 1893 was also very dry. A comparison of the mean values for twenty-five stations in England and Wales, during the months of drought, with the normal for 1881–1915 shows that the present year (February to July) has the least rainfall—49 per cent.—while 1887 (February to July) had 57 per cent., and 1893 (March to August) 65 per cent. If considered, however, from the point of view of frequency of absolute or partial drought periods at individual places, the present year was surpassed by both 1893 and 1911. Although we have had prolonged spells of hot weather, the maximum shade temperatures of 1911 have not been

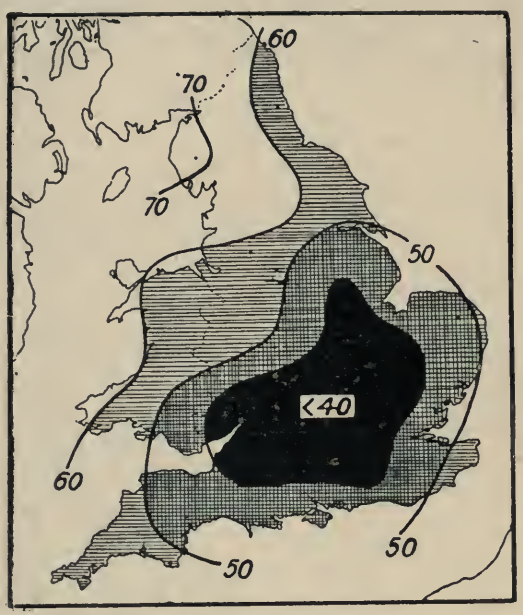


FIG. 1.—Rainfall, February–July, 1921. Per cent. of average, 1881–1915.

equalled. Woodland and moorland fires have been extensive and frequent, especially in Surrey.

In France the winter and spring were unusually mild and dry. Drought was severe in March and June, and persisted with only temporary breaks to the end of July. Paris rainfall, January 1 to July 15, was 104 mm., the normal being 236 mm. In Central and Southern France violent rainstorms occurred in July. Forest fires have been very numerous in Northern France and Belgium.

The winter was abnormally dry in Switzerland, with comparatively little snow. Early in January the Rhine and Rhone had shrunk to half their ordinary volume, and the general lack of water caused great restriction of electrical services. The winter is stated to be the driest for ninety years. Similar conditions were maintained throughout the spring, and June was so hot and dry that rivers were 6 ft. below normal, and the snow-line on the mountains receded more than 300 ft. On July 28 a shade temperature of more than 100° F., the highest since 1870, was recorded at Geneva.

In Norway, Denmark, and Germany forest and moorland fires were frequent in July after a spell of hot, dry weather. Central Europe generally does not, however, appear to have had the same degree of drought as North-western Europe. There was no rainfall deficiency in Germany in April to June, and temperatures, on the whole, were not unusually high, but drier conditions established themselves in July. In April Austrian temperatures were below normal, and rainfall, on the whole, above, in some cases two or three times the normal. In May, however, rainfall was deficient, and mean temperatures up to 7° F. above normal were experienced. Rainfall was also below normal at Budapest in April.

In Russia the drought has been very severe and prolonged, particularly in the south and south-east districts. Crops have consequently failed almost universally, so that a famine of unparalleled magnitude is threatened.

There is no information yet available from the bulk of the Asiatic continent. Winter snowfall in Baluchistan and the hills of the Punjab and North-west Frontier regions was the smallest for many years, but that in North-east Persia was normal. The monsoon broke rather late in India (June 22), but in spite of a lack of rainfall in the Bombay Presidency early in July, afterwards relieved by a week's rain, Indian rainfall has been quite satisfactory in general. Heavy rainfall, associated with a gale in the Mediterranean, caused a sudden rise of the Tigris in April; later on a period of intense heat set in in Irak and the Persian Gulf region. This is the hottest weather experienced since the British landing in 1914, and a shade temperature of 128·9° F. is stated to have been reached on July 16. If confirmed, this will constitute one of the highest shade temperatures ever recorded. Normal weather prevailed in Japan in April, but heavy rain and floods occurred in certain regions in June. Rainfall at Hong-Kong between January 1 and April 30 was 217 mm., the normal being 295 mm.; the temperature was not exceptional in April.

In Algeria, April and May were cloudy, with rainfall above the normal, and rather low temperature. The Nile was below its usual level up to June, and the Blue Nile was also low in May, owing to the lateness of the rainfall in the Abyssinian mountains. In June a rainfall unprecedented for the season occurred in Lower Egypt, a fall of 22 mm. being recorded at Ezbekia. During thirty-five years measurable rain has fallen only on one occasion in June, and it barely exceeded 1 mm. Apart from this, Egyptian temperature and rainfall were not remarkable during April to June, being somewhat above normal in some parts, and below it in others. At Dar-es-Salaam the total rainfall of April and May was 25 per cent. above normal.

There has been much hot weather in Canada, and rainfall, while by no means absent, has been deficient in many parts during the last three months. It is stated that there has been no such

long period of intense hot weather in the history of the province of Ontario, and the same applies to the whole of Eastern Canada, where shade temperatures ranging from 95° F. to more than 100° F. have been reported. The heat has caused much interruption of work, and destructive forest fires have been numerous. The harvest will be an early one, but, on the whole, is nearly up to the average.

New York suffered from several hot spells in June and July, an unusual feature being the accompaniment of exceptionally high humidity, which intensified their effect. In the latter month the whole of the middle section of the country eastward of the Rockies experienced great heat. There does not seem to have been any general deficiency of rain. Further south the cotton-growing districts had an excess of rainfall in July, and the crop will be very poor unless fine, dry weather supervenes.

Little information is available from Central and South America, but British Honduras had rainfall and temperature below normal in April, rainfall above, and temperature below, normal in May, and drought at the beginning of June. Peru has been suffering from drought sufficient to reduce the maize crop to half its usual value.

In Southern and Western Australia temperature was above normal during last summer in that continent. A shade maximum of 108° F. was registered at Perth on January 21, the highest on record for that city, and at Adelaide on more than one occasion the thermometer was 2° higher. Sydney temperatures were, however, below the normal. There was a spell of dry weather in Victoria, South Australia, and New South Wales in April, but rain fell in May. Early in June there was heavy rain in many parts of Queensland and New South Wales, and in July heavy gales and rainstorms swept the country from Sydney northward to Queensland, and were followed by disastrous floods in the coastal rivers. Later the weather in New South Wales and Victoria was the coldest experienced for a quarter of a century, and snow fell in districts where it has never been seen before. South Australia, up to June at any rate, had experienced a dry and unusually mild winter.

The open winter in the Arctic regions has caused an abnormal number of icebergs to be scattered over a large area of the North Atlantic Ocean, and conditions are worse for ships than they have been for many years.

To summarise, so far as information goes at present, the drought has been mainly European, chiefly in North-west Europe and Russia. Canada has had extremely hot weather, but without a serious deficiency of rain. The season in Australia has been abnormal, and there are indications of abnormal conditions in other widely separated regions, notably Irak and Peru. The only region of special excess of rain in the northern hemisphere appears to have been the Southern United States.

The Disaster to the Airship R38.

THE suddenness of the catastrophe—and the terrible death roll have directed the attention of the whole world to some aspects of airship construction. With the airship Britain and America have lost many valuable lives and a great amount of personal knowledge irreplaceable at short notice. A tribute to the bravery of the crew can be given with all sincerity, for some at least were aware of the fact that the airship was a great experiment, and on some important points designed without sufficiently exact knowledge of the conditions to be met. Not that anyone anticipated a collapse so complete and immediate as that which occurred, when the first warning was too late to enable experienced members of the crew to use the parachutes provided.

There have been less severe accidents to British airships in the past, but the cumulative effect had been to give some confidence in their ability to take appreciable damage without total failure. By taking the simple precaution of flying into the wind on the outward part of a trial flight, an airship when partly disabled has hitherto been able to return to its base quickly and safely. No parallel to the estimate of five seconds from first warning to fracture of the hull appears to exist.

It is too early to draw final deductions from the accident, for the evidence is incomplete, and the consequential failures are certain to mask, if not wholly to hide, the source of initial weakness. It may be gathered from the reported statements of eye-witnesses on the ground and survivors from the airship that the most probable element of failure was some weak member of the hull structure. The explosion, whether of petrol vapour and air or escaped hydrogen and air, followed the failure of girders amidships. It has been suggested that the breaking stress might have been imposed by a rapid application of the rudder in an endeavour to produce the equivalent of a gust of wind from the side. Whether this be true or not, it is probable that no one was able to estimate the forces which would result from the manœuvre. Airship design as known to us has been a matter of experience and guessing, and not of calculation founded on scientific knowledge. Policy, first dictated by the Admiralty and more recently by the Air Ministry, has never given any effective opportunity for the accumulation of the scientific knowledge on which alone rapid advance in construction could safely proceed.

In the early days of rigid airships the breaking of naval airship No. 1 at Barrow was followed by

a cessation of activity by the Admiralty, and not until the early months of the war was airship construction entered upon with vigour. Having neither knowledge nor experience of our own, Britain was reduced to copying, as faithfully as possible, such German designs as we were able to capture. That lack of knowledge, and not a concession to essential utility, accounts for the present calamity may be inferred from the fact that the weight of the girders and gas fabric was much less than one-half of the gross weight of the ship, and that a modification of the proportions of total weight could have been made for the purpose of strengthening the girders had the necessity been foreseen.

The Air Ministry has assumed a great responsibility by its failure, during the last two years, to provide adequate facilities for fundamental research on airships. Now, for the second time, airship development is to be abandoned, and no further research is to be undertaken. This can be justified only if airships are always to be useless, a decision which may reasonably be questioned. Whatever may be the future of the airship, it appears to be true that the British authorities have never allowed it an opportunity of justifying itself, and the loss of R38 is not improbably due to lack of a fair field for the designer rather than to insuperable defects of the system of construction.

Fuel Problems and Prospects.

By PROF. JOHN W. COBB

THE "James Forrest" lecture which was delivered before the Institution of Gas Engineers by Sir George Beilby on June 28 was given the title "Fuel Problems of the Future," and is one of the most comprehensive and interesting surveys of that subject which the present writer has had the pleasure of reading. Commencing with the proposition that "civilisation on its physical side is based on fuel," the lecturer proceeded to show what he meant by some picturesque and relevant illustrations, beginning with "the kindling of the first fire of dried leaves and branches by our prehistoric ancestors," which established "a new dividing line between man and the lower animals by mitigating the horrors and dangers of the darkness of night, and arousing social instincts."

The more prosaic subject of the price of coal, however, soon found its inevitable place in the lecture, and it was indicated how every one of us is being penalised not only by the dearness of the coal supplied, but also by its inferior quality, arising from the unwarrantable and unnecessary introduction of useless stones and shale. This brought on a reference to the new Gas Act, with its new principle of paying for "therms," but not for inert material, and an extension of the principle involved to coal itself was suggested.

If the gas undertaking is in future to be paid only for the therms delivered to the consumer, it is entitled to throw at least a portion of the responsibility on the coalowners and miners by paying only for the potential therms received in the coal, and not for the inert and inferior materials, which are not only valueless and detrimental to economical working in the retort-house, but lower the value of the coke produced.

Coal is, of course, the dominating fuel in these islands, and Sir George Beilby's survey does not leave that in doubt; but the fuel position of the world as it is disclosed by the most recent figures of production for all kinds of fuel is subjected to comprehensive review. If an authoritative pronouncement were made that a new fuel was available in these islands which could compete effectively with coal, or was likely to be able to do so in the near future, it would arouse a natural enthusiasm, but, so far as this country is concerned, no comfort of that kind can be derived from dispassionate consideration of the facts of the case. The very interesting point is brought out, however, that Germany is facing, and indeed has already faced, the fuel problem of the immediate future, so far as she herself is concerned, by an extensive development of the lignite industry.

The glowing accounts of this development which have appeared in the technical Press during the past two years may have struck us as exaggerated, but the solid fact remains that the output of lignite in Germany last year was 111,000,000 tons.

This brown coal, though it contains from 40 to 50 per cent. of water, is to-day by far the cheapest source of thermal units. The deposits are often of great thickness, which can be worked open-cast and excavated by machinery with relatively little manual labour and light capital charges. Victoria (Australia) is also developing extensive deposits of brown coal, which are known to exist in Central Gippsland, and Canada is experimenting on the briquetting and carbonisation of the brown coals of Manitoba and Saskatchewan.

The other great source of fuel is oil, of which "the world's output for 1920 is estimated at about 97 million tons, of which

	Per cent.
The United States produced	64·8
Mexico produced	23·3
Russia produced	3·5
Dutch East Indies produced	2·5
India produced	1·2
Rumania produced	1·1
Persia produced	1·0
Countries producing less than 0·5 per cent. produced	2·6
Total	100·0

The amount seems large, but is only some 7 per cent. of the fuel output of the world reckoned

in tons, or 10 per cent. in potential therms. Sir George Beilby discussed the possible exhaustion of these resources in view of the rapid development in the use of motor spirit for motor transport and of fuel oil for transport by sea. He pointed out that it is only the rapid development of production in Mexico and the extensive interests of the United States in this production which have prevented the actual danger of shortage in America from becoming acute, and gave a long extract from a statement by Mr. J. O. Lewis, chief petroleum technologist to the United States Bureau of Mines, defining the position in that country. The conclusion of this authority is that America is quite rightly concerned over the domestic supplies of petroleum from oil wells, but, on the other hand, there are known deposits of oil shales which, in three States alone, promise to yield many times more oil than will ever be recovered from the oil wells of the United States, and that there is no concern as to the ultimate supply. He also believes it probable that eventually alcohol could meet the American needs should gasoline fail.

This brought Sir George Beilby to the consideration of alcohol, and to the inquiries of Mr. Walter Long's Committee, and of the Fuel Research Board with Sir Frederick Nathan as Power Alcohol Investigation Officer. With alcohol one difficulty is that the most suitable raw materials for its manufacture are as a rule also important foodstuffs, but experiments in Burma appear to indicate that the joint production of alcohol and paper from waste rice straw should be commercially possible, and research work for developing the use of cellulosic materials in alcohol production is reported as in hand. Sir George Beilby appears to think that the commercial production of alcohol on these or similar lines for local consumption will soon be established in various parts of the Empire, but that there is no immediate prospect of alcohol counting for very much as an imported fuel for use in this country.

An interesting account was given of what has been done in the winning and utilisation of peat, but a fundamental difficulty was stated in the following sentence:—

> When it is realised that the peat deposit in a good bog 20 ft. deep is only the equivalent of a 12- or 14-in. seam of coal, it will be evident that even an output of 1000 tons a day of air-dried peat involves the laying-out and development of an enormous surface.

Prof. Pierce Purcell has been acting as Peat Investigation Officer of the Fuel Research Board, and 100 tons of air-dried Irish peat have been tried for boiler-firing and carbonisation, with quite encouraging results. But it will be understood that although the lecturer passed in review various fuels which had interest and value, he did not allow it to be forgotten that "coal is likely to remain the chief source of fuel, not only for Great Britain, but for the world at large, and that the problems of its winning, preparation, and use still occupy the foreground in all serious consideration of the subject." He declared that "the greatest of the fuel problems of the future was to decide what proportion of the total coal consumed it will pay to subject to a preliminary operation of carbonisation or gasification, with the object of sorting out the potential thermal units of the coal into groups of higher availability or greater convenience as fuels, *e.g.* gas, motor spirit, fuel-oils, and coke." He pointed out once more that "though the operations of carbonisation and gasification involve the expenditure of some heat, the loss may be more than compensated for by the increased value of the new fuels."

Sir George Beilby has been interested for many years in low-temperature carbonisation and its possibilities—in the production of a solid, smokeless fuel for domestic purposes by the carbonisation of selected coals at 550° to 600° C. The matter is being taken in hand by the Fuel Research Board at its experimental station, and data have been acquired as to the yields and quality of the gas, oils, and coke produced under definite conditions; but, as the lecturer clearly indicated, the problem has two distinct sides, the technical and the economic, and it is very difficult to determine with any certainty the resultant of the commercial forces at work, which change their value in such a disconcerting way. Hence this cautiously worded summary of the position:—"My own belief is that low-temperature carbonisation can only be established on a sound commercial basis with low operating costs and a very moderate margin of profit." It is, however, to be hoped that the technical results obtained by the Fuel Research Board in its experiments, which should have a permanent value, and can be connected up with other factors in considering the commercial position of any such process, will be published as soon as they are available. Information on this subject from an unbiassed and competent authority is wanted, and may serve to correct the extremes of laudation and condemnation to which we have become accustomed.

Considering how large are the quantities of coal used for steam-raising, Sir George Beilby rightly directed attention to the possibility of a large saving in fuel without any considerable capital expenditure which might be effected if steam plants were kept in order and their working properly supervised. Such supervision should begin, of course, with the coal itself, so soon as it becomes possible to exercise any reasonable degree of choice in that matter. The work of Mr. Brownlie, who has undertaken quite an extensive survey of steam-raising plants in some of our principal industries, has been very useful in this connection. As the lecturer pointed out, even if a moderate increase in efficiency of 10 per cent. were effected in the steam-raising plants of the country, it would result in a minimum saving of $7\frac{1}{2}$ million tons per annum. Mr. Brownlie's

own experience leads him to take a much higher saving as a possibility.

The last part of the lecture was given up to a description of the new position of the gas industry since the passing of the Gas Regulation Act of 1920, which instituted the charging for gas by the therm and removed many useless restrictions. The new Act, which was based upon recommendations by the Fuel Research Board, will, in effect, not only make it possible to obtain and distribute as gas a portion of the volatile matter of the coal, but also permit much more extensive gasification of the fixed carbon. This should open out quite a new field of efficiency and economy. The lecturer referred in particular to one modern development in the gas industry on these lines which has been investigated with considerable thoroughness during the last three years. The process of increasing the yield of gas by passing a current of steam through continuous vertical gas retorts while carbonisation is being effected was investigated by a joint committee of the Institution of Gas Engineers and the University of Leeds, and the results were presented to the Institution of Gas Engineers at its annual meeting in 1920. These results, including chemical and thermal balances obtained with different quantities of steam, were obtained from one Scottish coal, but similar work extended to English coals and carried out later at the experimental station of the Fuel Research Board has added to our knowledge. "We can now say with confidence that there is not only a very substantial gain in therms in the form of gas, but also in the yields of tar and ammonia," when the steaming process is employed.

Sir George Beilby concluded his lecture by a brief summary and a reference to the present spirit of unrest, which complicates fuel and all other problems into which the human element enters :—

This spirit, as it is manifesting itself to-day, is fatal to the progress of reconstruction and development on any extensive scale, and we, whose chief interest in life lies in the control and use of the power and resources of Nature for the service of man, can only continue to do the work next our hand, while we cherish the hope that the better side of human nature, which we know is only temporarily overshadowed, will gradually reassert itself.

The "Proletarisation of Science" in Russia.

By DR. BORIS SOKOLOFF (formerly Lecturer, Petrograd University).

"Science? What is science? It is only a tool in the hands of clever politicians."—From report of a public discussion on science held in the Petrograd Palace of Labour, September, 1920.

SCIENCE in Russia is now passing through difficult times. The experiments being carried out by the Bolshevists in Russia are opposed to it—how could it be otherwise? Everything—art, education, poetry—have been "proletarised"; why not science? During the whole of the year 1920 a campaign was being carried on against "bourgeois science." In the Press and at special meetings complaints were made of the reactionary tendencies of professors, of their strange indifference to politics, of the necessity of turning scientific men into advocates of the Soviet system. By the phrase the "proletarisation of science" the Bolshevists seem to understand a reorganisation of the methods of scientific investigation, the broadening of its basis, and its practical application. But the real idea at the back of their minds is to make science serve the ends of Bolshevism. This view was expressed as follows by Communist speakers at the Petrograd Students' Conference :—

Comrade Lounatcharsky is quite right in saying that science is now in the hands of mandarins of bourgeois origin. We must appropriate science; we must make it pro'etarian. In the place of professors and scientific men imbued with political indifference and *bourgeois* ideals we must put real proletarians, learned men who will be able to create a science which will be obedient to us.

Such is the theory. The "proletarisation of science" in this sense is a matter of the independent reconstruction of scientific methods. But, in practice, the "proletarisation of science" is quite a different thing.

Science is the crown of the human intellect; it is the sun which man has created from his own flesh and blood. It is necessary to realise that the work of a man of science is the property of humanity as a whole. Science inhabits the domain of the highest altruism. Scientific workers must be considered as the most valuable of men, the most productive element of society. The premature death of a man of science means a great loss to the country; this must be fully understood by the workers' Government.

Look at the death-roll of scientific men within the last few months, and you will see how great is the loss of scientific energy in our country. If this process of extinction of learned men continues at the same rate, Russia will be deprived of her brains. Free science is indifferent to politics. (Petrograd journal, *Science and its Workers*, No. 1 : article on "What is Science?")

So writes Maxim Gorky, a supporter and faithful adherent of the Soviet Government. He writes, he tries to convince—whom? Not, of course, the Russian *intelligentsia*, who know the state of affairs better than Gorky himself. Gorky's appeal is evidently addressed to Bolshevists, to the Soviet Government. However, they can neither understand nor appreciate the appeal. Being men of simplified views—doctrinaires and politicians—they cannot accept the fact that science must be independent of everybody and

everything. They think it quite right and advisable to make scientific men "obedient" executors of the commands of the Soviet Government.

During the last three years the "Palace of Science" registered the names of 420 Russian professors and scientific men who died from starvation. These are not occasional sad events; they constitute something regular, systematic. Letters which I have received from my friends and colleagues—Russian scholars—give a vivid picture of life under Bolshevism. For obvious reasons I cannot give the names of my correspondents.

"These two and a half years," writes Prof. X, "have been a continuous nightmare. The Bolshevists declare us to be parasites and drones, and we have been deprived even of the scanty ration allowed to workmen and soldiers. Those of us—and not many were so lucky—who had any spare garments or possessions sold them in order to buy food. Those who had nothing sold their books, and that was the most terrible. . . ."

A professor of philosophy writes:—

It is easier for me than for others to understand Bolshevism. In it is something wild, something of the Russian recklessness. The experiments of the Bolshevists remind me of the Eastern mountain tribes; in the life of such tribes blood-revenge is closely connected with primitive communism. I am rather interested in the Bolshevists, impartially, as a philosopher should be. I do not mind the water freezing in my room, that instead of bread and meat I eat raw oats, or that one can write and create in Soviet Russia only during the summer months. But there is one thing which makes me despise the Soviet Government, and that is their endless lying.

"No, I and the Bolshevists cannot understand each other," writes the Moscow Prof. W. "I, an old man, who can scarcely walk, whose feet, on account of the cold winter, are sore and swollen, am kept in solitary confinement. May God forgive them; they have their own convictions; I am not angry with them, but why do they try to frighten me by stupid examinations? Yesterday I was again taken to be examined. . . . They cannot understand that one can be devoted to science without caring for politics; no, they cannot understand that."

Not until 1920, after many eminent Russian men of science had perished, did the Bolshevists establish a so-called "science-ration." But even this ration was repeatedly reduced and sometimes entirely stopped.

What is the attitude of scientific men towards the Bolshevists? This is a very complicated question. If we put aside the personal grievances which everyone now has owing to the grave economic situation, and consider the question from its logical side, we shall see how complicated it is. For example, there is Prof. Gredeskul, who urges the *intelligentsia* to join the Communist party; there is Prof. Behtereff, who declares that all Russian men of science now abroad should return to Russia; there is Prof. Pavloff, the declared anti-Bolshevist. As a general rule, learned men are not Communists; only a few of them have joined the party: Pokrovsky, the late Prof. Timiriazeff, Gredeskul. I am unable to find any other scientific men who would say "we Communists." A few Communists may be found amongst the young laboratory and lecture-room assistants, but all of them are quite unknown to the outside world; they have no scientific or public standing. The main body of Russian learned men is openly opposed to the Bolshevists—of course, among them are various shades of opinion, very interesting and characteristic.

Another group of savants, among them many prominent men, hold the view that they must defend the interests of pure science.

As Russian citizens, when we are outside our laboratories and universities, we say: "Down with the Bolshevists!" They have brought only damage and shame to Russia, and can bring nothing else. But as scientific workers we have another grievance. Russian science, that part of culture which belongs to the whole of humanity, must be saved from annihilation. We, the servants of science, must do all in our power to preserve her in Russia, to save the lives of Russian men of science, to reawaken her creative power in our country. We must, for the sake of science, make concessions to the Bolshevists; they appoint their commissaries to our laboratories and institutions—we must not object to this measure; they put us under a military *régime*—we must accept even this. We believe, we know, that Bolshevism will soon pass; meanwhile, we will do our best to preserve the eternal human culture. We believe that scientific work is quite possible under Bolshevism, in spite of the Bolshevists.

They did believe in this, but now their belief is waning, though they are still ready to accept any kind of compromise in order to preserve science and scientific institutions. To this group belong the academicians Oldenburg, Fiersman, Behtereff, Prof. Tarasevitch, Lasareff, Rojdestvensky, and many others.

Then there is the last group of Russian men of science, which embarrasses the other Russian scientific workers. These say:—

We are far removed from politics. We do not believe in the Bolshevists; we do not consider them to be either idealists or revolutionaries; we consider them as men who seized the State power by main force and now are willing to govern the country by force. They suppress every movement towards freedom; they cannot endure any independence apart from themselves, because they are afraid that the freedom and independence of the people will ruin Bolshevism. We do not believe in the Bolshevists. We were witnesses of the appeal of Lenin to the intellectuals when he asked them to collaborate with the Bolshevists. That was a year ago. But what did Lenin mean by "collaboration"? To be his lackeys? To carry out his orders? We were witnesses that this same Lenin, who in April asked the intellectuals to collaborate, in May shot many hundreds, and even thousands, of educated people. Why?

No, we do not believe in the Bolshevists.

Such is the theory and the practice of the "proletarisation of science": in theory—the peaceful reorganisation of science; in practice—its destruction, its exploitation for political purposes.

At this stage of Russian life two principles are

struggling in the most fateful way: one, which unites synthesis and analysis, which seeks the truth of to-morrow, which has nothing to do with politics and political parties; the other, which is entirely subjective, full of personal ambitions and views, which is devoid of analytic conceptions, and is born of the evils of to-day.

Science is struggling with politics for its freedom; politics is struggling with science for its triumph. It is a struggle which, alas! human history has witnessed many times, but which has always ended in victory for science. It did seem that this useless struggle would not have to repeat itself again; yet now the fierce combat is going on in Russia; the old times of the Middle Ages have once more returned on the earth. The Bolshevists are repeating in many ways the long-forgotten past, though they themselves are convinced that for the first time they are propagating a new creed.

Physical Effects Possibly Produced by Vision observed by Dr. Russ.

By DR. H. HARTRIDGE.

THE rise and fall of scientific theories forms a topic for study almost as interesting as does the supersedence in history of one dynasty by another. Newton's corpuscular theory of light was displaced by the wave theory in much the same way as the teaching of Aristotle supplanted the older view of Plato—that in vision emanations proceed forth from the eye to strike the objects looked at. But just as modern physical research has revived certain aspects of the corpuscular theory, so the researches of Dr. C. Russ ("An Instrument which is Set in Motion by Vision or by Proximity of the Human Body," *Lancet*, July 30, p. 222) have recalled to memory the views of Plato. For these researches have shown that certain instruments react when the human eye is directed at them.

One instrument used by Dr. Russ consisted of a solenoid suspended by a single fibre of unspun silk within a case composed partly of glass and partly of metal, in such a way that the contents were shielded from air-currents. Above the solenoid was mounted a small permanent magnet, so that the suspended solenoid set itself in a constant meridian under the earth's magnetic field. In another instrument the solenoid was replaced by a condenser, oppositely charged metal plates being mounted outside the instrument-case. With both instruments it was shown that a rotation of the suspended system occurred when the gaze was suitably directed through a slot in the outside casing. As to the precise details of the rotation, the description is not very clear, but it seems that when the gaze was directed to the centre of the suspended system no rotation occurred; when, however, the gaze was directed on either side of the system, then that side rotated away from the eyes some 10 to 45 degrees, and then again came to rest. If the gaze continued to act, the deflection remained unaltered; but if the eyes were then closed, the index returned to zero.

In earlier experiments the rotation of the instrument was directly observed by the human eye; later, however, the instruments were fitted with concave mirrors similar to those applied to reflecting galvanometers, so that the rotation could be measured in the ordinary way by the movement of a spot of light on a scale. Besides demonstrating that rotation of the instruments occurred under the action of the gaze, Dr. Russ also found somewhat similar effects if the fingers were held near the instrument.

Nothing definite is known at present as to the explanation of these effects, but Dr. Russ made the following preliminary alternative suggestions:—

1. That the effects are due to changes of temperature.

2. That they are due to the electrical changes which accompany vision and muscular action.

3. That electrostatic forces are responsible for them.

4. That the eye may emit electromagnetic waves (*e.g.* visual, infra-red, ultra-violet, and X-rays).

With regard to the above suggestions, it may be said that temperature changes are not likely to be the cause, for hot objects placed in suitable positions near the instruments produced either no effects, or effects very much smaller than those producible by eye or hand. Electric changes produced in muscle or in eye can, I think, be safely ruled out, because of their smallness and because of the closed circuits which the connective tissues, skin, etc., form over them. To demonstrate or to measure these currents, the retinæ or muscles must themselves be connected to the leads of the galvanometer. Dr. Russ apparently ruled out the possibility of electrostatic changes being responsible, by finding that the directing of the gaze through a fine metal grid connected to earth (which would screen off electrostatic charges) did not prevent the instruments from reacting to the gaze as usual.

Lastly, in favour of the effect being an optical one (I intend X-rays to be included) are the following facts found by Dr. Russ:—

1. That interposing a column of water between the eye and the instrument reduced the effects.

2. That the effects are very much smaller, or

are quite absent, in the dark. (Dr. Russ's words are: "I did four tests which seemed to give a positive effect.")

3. That if a strong beam of light be allowed to fall on the suspended system of the instruments the gaze has no longer any effect.

There are no grounds on which a definite conclusion can be based, but I think the inference is that the effect is an optical one.

Measurements should therefore be made to see what electromagnetic rays are responsible for the effects. (1) Are they stopped by a thick slab of lead glass? If they are, they are probably X-rays. (2) Are they stopped by æsculin or by β naphthol disulphonic acid? If they are, they are probably ultra-violet rays. (3) Are they stopped by strong methyl-violet? If so, visual rays may be responsible. (4) Are they stopped by a saturated solution of ferrous sulphate in water? If so, then they may be infra-red rays.

In the next place tests should be applied to see if the rays obey the ordinary laws of (*a*) reflection, (*b*) refraction, (*c*) polarisation, (*d*) inverse squares. In fact, everything should be done to correlate Dr. Russ's observations with known physical laws, before metaphysical explanations are even thought of. Since writing the above I have seen a letter in the *Lancet* of August 6 in which Dr. J. D. Suttie points out that another conclusion can be drawn from Dr. Russ's experiments. For example, in the experiment in which he found that the side of the solenoid looked at rotated away from him, what Dr. Russ was really doing was to place the fixation point of his fovea co-ordinate with the side looked at. But Dr. Suttie observes that all other parts of the solenoid would be equally co-ordinate with some other part of the retina, and that if all parts of the retina were equally active there is no reason why any movement should take place, since the forces on the two sides would balance. Therefore he argues that the effects obtained by Dr. Russ drive us to the conclusion that the fovea is very superior to the rest of the retina in the degree of its activity [If it were very inferior, the same explanation would equally hold good.—H. H.], and holds further that the force ("if there be such") "is refracted by the optical media of the eye in a manner similar to light."

Dr. Suttie then goes on to suggest that "the deviation [refraction by optical media?] of the force would supply a valuable clue as to its nature, and that obvious controls would be to test persons whose retinas are inactive through disease, or who suffer from opacity of the eye media (*e.g.* cataracts)." With these points of Dr. Suttie's letter I entirely concur.

In his reply to Dr. Suttie's letter Dr. Russ (*Lancet*, August 13) writes: "His [Dr. Suttie's] reference to cataracts as controls is surely a feeble suggestion." To me, at all events, it seems clear that Dr. Russ has entirely missed the point of Dr. Suttie's suggestion, viz. that tests on an eye with a cataract would decide whether the effects found by Dr. Russ are due to forces originating from eye structures lying in front of or behind the crystalline lens. Surely not a "feeble" suggestion at all, but a very valuable one! It seems to me that it is not in regard to this suggestion alone that Dr. Russ has misunderstood Dr. Suttie.

Obituary.

PROF. G. T. LADD.

DR. GEORGE TRUMBULL LADD, who died at New Haven, Connecticut, on August 8, was born at Painesville, Lake County, Ohio, in 1842. In 1879 he became professor of philosophy at Bowdoin College, and two years afterwards, in 1881, was appointed to the chair of philosophy at Yale. Later he was elected Clark professor of metaphysics and moral philosophy at the same university, a position which he occupied until 1905, when, on his retirement, he received the title of emeritus professor. As a lecturer Prof. Ladd was well known in other countries besides America. Three times—in 1892, 1899, and 1907—he gave courses of lectures in Japan, and in 1899 and 1900 he visited India, lecturing in philosophy at the University of Bombay, and in the philosophy of religion at Calcutta and elsewhere. He was in England in 1911, and was present at the first of M. Bergson's lectures on the nature of the soul at University College, London, in the October of that year. His writings are numerous, and many of them voluminous. Certain of his books have been widely used in the universities of the United States and of this country.

So far back as 1887 Prof. Ladd published his "Elements of Physiological Psychology," which was based, to a large extent, upon the second edition of Wundt's "Grundzüge," but had distinct merits of its own as an independent compendium and discussion of the psychophysical material then available. A revised edition appeared in 1911. A more important and original work of his is that which saw the light in 1894, "Psychology, Descriptive and Explanatory"—as was said of it at the time: "Literally a weighty production, it turns the scale at three pounds avoirdupois."

Prof. James Ward's Encyclopædia article had appeared nine years before, yet Prof. Ladd's volume, in certain respects, broke new ground, to which, however, Prof. Ward's article had obviously prepared the way. In particular, the divisions of the book involved the complete abandonment of the old and vicious doctrine of "faculties," and in it the conception was consistently adopted that the formation and development of a so-called faculty were themselves

precisely the things which scientific psychology had to explain. Doubtless the author was inclined to lay too much stress on the view that the different "faculties" all resulted from the combination of the same elementary processes, and that each differed from the others by emphasising, so to speak, one principal kind of these processes, whereas the more fruitful procedure has been that of seeking to exhibit such "faculties" rather as differentiations of one common process. Nevertheless, his treatment of the growth and development of mental life, and especially of the higher forms of cognition, is illuminating and suggestive. In regard to feeling, he argues, but scarcely in a convincing way, against the view that pleasure and pain stand out as the only distinguishable qualitative differences characterising the primary experience we designate feeling.

In 1895 Prof. Ladd published a work entitled "Philosophy of Mind: An Essay in the Metaphysics of Psychology," in which were handled the problems which psychological science passes on to philosophy for a more thorough examination—problems started, for the most part, by that mode of human experience which is described as the consciousness of self. He maintained that a mind is a real being which is known as a self-active subject of states and as standing in manifold relations to other beings. The theory of psychophysical parallelism is vigorously criticised by him, and the theory of interaction defended.

In the volume of *Mind* for 1892 Prof. Ladd gave an interesting account of some researches of his concerning the influence of the *Eigenlicht* of the retina upon visual dreams—a subject that deserves more attention than it has hitherto received. He was one of the first to introduce the study of experimental psychology into America, and the Yale psychological laboratory was founded by him.

As a philosophical thinker Prof. Ladd was greatly influenced by Lotze, whose "Dictate" he translated into English. Perhaps his most distinctively metaphysical work is that entitled "A Theory of Reality," published in 1899. It presents a continuation of the line of thought he had pursued in an earlier book called "Philosophy of Knowledge," published in 1897, in which he had found that the categories of the understanding are forms of reality as well as of truth; that the knower has, in individual self-knowledge, an intuitive insight into reality; and that other real existents are known by analogy of the self. In the metaphysical treatise he tries to show that the universe consists of real beings of various grades, each grade being distinguished by the amount of self-hood possessed by its members. What we name "things" are, in truth, imperfect and inferior selves. Neither "things" nor self-conscious lives are mere manifestations of an absolute mind, for all have self-activity and relative independence, yet they exist together as a unitary system which is related to the absolute mind as object to subject. The activities of finite entities are, in fact, twofold; they are at once acts of the finite entity and acts of the absolute being which is their ground. In this last contention, it is true, he cuts rather than unties the Gordian knot; the conclusion is one which human thought throughout the ages has been striving to reach, but has never succeeded in rendering logically tenable.

Two other books of extensive scope followed—the "Philosophy of Conduct" in 1902 and the "Philosophy of Religion" (two volumes) in 1905. The latter is an exhaustive treatment of the subject from both the historical and the speculative points of view, and has scarcely received the consideration that is its due. Prof. Ladd's literary activity was maintained to the end. In the last few years there emanated from his pen a series of popular manuals bearing the titles "What can I know?", "What ought I to do?", "What should I believe?", "What may I hope?", and "The Secret of Personality," all of them thoughtful and replete with the wisdom of experience.

G. DAWES HICKS.

THE death is announced, in *Science* of August 12, of MR. LOUIS ALBERT FISCHER, physicist and chief of the Division of Weights and Measures of the United States Bureau of Standards. Mr. Fischer died on July 25 last at the early age of fifty-seven years, only a few weeks after his distinguished colleague, Dr. E. B. Rosa. Early in life he joined the old Weights and Measures Office of the U.S. Coast and Geodetic Survey, and during his eleven years' service with the survey he carried out numerous tests for the standardisation of weights and measures, particularly of the length standards. This work led to the formation in 1901 of the National Bureau of Standards, in which Mr. Fischer took an important part. He was immediately appointed chief of the Division of Weights and Measures, and continued to hold the post until his death. During this time he conducted numerous investigations of scientific and technical value, which covered such subjects as the standardisation of chemical glassware, screw-threads and gauges, the thermal properties of various metals and alloys, the densities of water-alcohol solutions, the testing of watches and clinical thermometers, model laws for State weights and measures services, etc.

In 1905 Mr. Fischer organised the annual Conference of Weights and Measures of the United States, and afterwards acted as secretary to the organisation, which consists of national, State, and other officials interested in the promotion of uniform legislation regarding weights and measures. Mr. Fischer was regarded as the leading spirit of the last decade in America in all matters concerning weights and measures, yet in spite of the immense amount of administrative and technical work he accomplished, he also contrived to find time to carry out researches which have earned for him a reputation as one of America's leading metrologists.

Notes.

FRIENDS of the late Sir Norman Lockyer will be glad to know that 100*l.* has already been received for the portrait medallion which is to be placed at the observatory on Salcombe Regis Hill, but a further sum of 100*l.* is still required to complete the memorial. It is hoped that the medallion will be unveiled in the autumn, and donors will be notified of the date. Contributions should be sent to the hon. secretary of the Observatory Corporation, Capt. W. N. McClean, 1 Onslow Gardens, London, S.W.7.

A PRELIMINARY meeting in connection with the visit of the British Association for the Advancement of Science to Hull in 1922 has been convened by the Lord Mayor of the city. There was a representative gathering and a strong committee was formed. The town clerk, Mr. H. A. Learoyd, and the museums curator, Mr. T. Sheppard, were nominated as local honorary secretaries for the meeting, and the city treasurer, Mr. T. G. Milner, as hon. treasurer.

IN recent years an exhibition of botanical material has been a feature of the Section of Botany at meetings of the British Association. The recorder of the Section asks us to say that contributors who have material to exhibit during the forthcoming Edinburgh meeting should communicate their requirements at once to the local secretary, Mr. W. Wright Smith, the Botanic Gardens, Edinburgh.

A PUBLIC meeting has been arranged by the National Union of Scientific Workers to take place at 5.30 on Tuesday, September 13, in the new buildings of the Medical School, Edinburgh University, for the delivery of an address by Prof. H. Levy on "The Function of the Man of Science in Organised Research." The address will be followed by a discussion to be opened by Prof. H. H. Turner. The meeting will be presided over by Sir Richard Gregory.

A MEETING of the Royal Meteorological Society will be held in the Natural Philosophy Department of Edinburgh University on Wednesday, September 7, at 2.30, when the following papers will be read:—"The Functions of a Scientific Society, with Special Reference to Meteorology," R. H. Hooker; "Meteorology in Medicine," Dr. A. Macdonald; "Some Notes on Meteorology in War-time," C. J. P. Cave; "The Diurnal Variation of Pressure at Eskdalemuir, 1911–20," Dr. A. Crichton Mitchell; and "The Natural Tendency towards Symmetry of Motion and its Application as a Principle in Meteorology," Dr. S. Fujiwhara.

THE annual general meeting of the Institution of Mining Engineers will be held at Stoke-on-Trent on Wednesday, September 14, when the following papers will be read or taken as read:—"The Adsorption or Solubility of Methane and other Gases in Coal, Charcoal, and other Substances," by J. I. Graham; "Suggestions for the Standardisation of Geological Sections of Strata proved in Boreholes, Shafts, etc.," by H. Roscoe; and "Coal-mining by Steam Shovel in Alberta, Canada," by G. Sheppard. The following papers, which have already appeared in the Transactions, will be open for discussion:—"Third Report of the Committee on 'The Control of Atmospheric Conditions in Hot and Deep Mines': Observations of Temperature and Moisture in Deep Coal-mines," by J. P. Rees; and "Characteristics of Outbursts of Gas in Mines," by Prof. H. Briggs.

SIR C. H. BEDFORD has been appointed honorary adviser to the Secretary of State for the Colonies on questions relating to power and industrial alcohol in the Colonies and Protectorates.

MR. B. A. KEEN, head of the Soil Physics Department, Rothamsted Experimental Station, has been awarded a travelling fellowship by the Ministry of Agriculture. He has left for America to inspect general agricultural conditions in that country, with special reference to problems on soil cultivation.

MESSRS. S. A. HODGES and T. A. Davies, of H.M. Dockyard, Portsmouth, have respectively been awarded the scholarship for 1921 of the Institution of Naval Architects and the Earl of Durham prize of the same institution.

FRANCE is already preparing to celebrate on November 22, 1922, the centenary of the birth of Pasteur. England probably, in her old insular way and her usual indifference toward men of genius not her own, will let the sacred day pass without much notice. But Pasteur's work lives and moves and has its being in every country of the world. If every Englishman and Englishwoman who has cause to be grateful to him and his followers would subscribe sixpence, we should obtain enough money for a life-size golden image of him, and more than enough. It is one of our national disgraces that there is no memorial to him in London. Why should we not next year wipe that disgrace off our national slate? Poor London, weighted with so many dull and grimy statues of lesser men whose life and work are not to be named in the same breath with his! There is a good bust of him at the Pasteur Institute: so let us have a replica of it, and let it stand between Miss Nightingale and Lord Herbert, in front of the Guards' Memorial. These three monuments bear witness to the days when our sick and wounded in war—and in peace likewise—died like flies for lack of protective treatments against disease and of antiseptic and aseptic surgery and nursing. Pasteur shall bear witness to our redemption out of our ignorance.

THE Ministry of Agriculture and Fisheries and the Royal Horticultural Society have arranged to hold an International Potato Conference in London on November 16–18 next. During the conference, which will take place at the hall of the Royal Horticultural Society, Vincent Square, the National Potato Society will hold its annual show, at which it is expected that most British varieties of potatoes will be exhibited. An exhibit dealing with the scientific aspect of potato problems is also being arranged, and it is hoped that workers engaged on potato problems in

all parts of the world will co-operate. The proceedings will open with Sir A. Daniel Hall's presidential address on the morning of November 16. Papers on the breeding and selection of potatoes in Great Britain and the United States, and on wart disease, potato blight, and other diseases which are botanically and economically important, will be read, and time has been allowed for their discussion. Invitations to attend the conference have been extended to the Dominions and Colonies and to foreign countries, and it is hoped that the meeting will be thoroughly representative from both the scientific and the commercial aspects. Arrangements for the meeting are in the hands of a committee representative of the Royal Horticultural Society, the Agricultural Departments of England, Scotland, and Ireland, the National Institute of Agricultural Botany, and the National Potato Society. The chairman of the committee is Lord Lambourne, and the joint secretaries are Mr. W. R. Dykes, of the Royal Horticultural Society, and Mr. H. V. Taylor, of the Ministry of Agriculture.

INFORMATION is to hand in a circular from the Brazilian Department of Agriculture that henceforth the meteorological and astronomical Government services united under the name "Directoria de Meteorologia e Astronomia" are to be separated, and will be known as the "Directoria de Meteorologia" and "Observatorio Nacional" respectively. The new Directoria de Meteorologia, of which Senhor Sampaio Ferraz has been made director, will, no doubt, lead to a desirable unification of official meteorology in a vast country like Brazil, and it is to be expected that the co-ordination of effort which should ensue will provide material for the study of a climate which is more or less unknown except in general outline. The publication before the end of the present year of climatological data of Brazil for the last nine years is anticipated, and among the activities promised under the new directorate are forecast, aviation, coastal navigation, agricultural, and rain and flood services. It is pointed out that Rio Grande do Sul, Minas Geraes, and San Paulo will continue their State services, but under the supervision of the Directoria, and that the Reclamation Service of semi-arid north-eastern Brazil will retain its rainfall organisation. Information on Brazilian climatology will be gladly given in answer to inquiries, and the Directorate hopes to exchange publications with foreign institutions. The official address is: Directoria de Meteorologia, Morro do Castello, Rio de Janeiro, Brazil.

AN interim report relating to alleged dangerous lights in kinema studios has been issued by the Departmental Committee on the Causes and Prevention of Blindness, acting on behalf of the Ministry of Health. Cases of inflammation of the eyes have been reported by Sir Anderson Critchett and others, but fortunately these injuries have been of a transient nature, and no instances of permanent serious injury are recorded. According to the evidence of experts, the trouble is due mainly to the use of very powerful arcs of the searchlight pattern in an unshaded condition. Such lamps are considered liable to cause injury owing to the unimpeded access of ultra-violet rays, and it is also possible that artists looking direct at the lights, even if properly screened, may suffer owing to the intense visible light. Moreover, irritating vapours may be given off by some forms of carbons and occasion trouble at close quarters. The Committee, however, considers that the possibilities of injury would be slight if all lamps were properly screened, and the evidence of photographic and other experts supports the view that these methods of diffusion are also preferable from the technical point of view. An assurance has been given by the Incorporated Association of Kinematograph Manufacturers that in future no open arc lights without glass filters will be used in their studios. Now that the source of the trouble is recognised, no further action is considered necessary for the present. The Committee, however, remarks that the industry is in a state of development, and that further research is desirable. It accordingly welcomes the information that the Illuminating Engineering Society is forming a joint committee to study these problems in detail.

A COMPLETE list of awards and grants from the Rumford Fund for Research in Light and Heat forms No. 10 of vol. 56 of the Proceedings of the American Academy of Arts and Sciences (July, 1921). In previous publications in 1905 and 1912 dealing with the Rumford Fund, outlines of the history of the funds of that name of both the American Academy and the Royal Society were given, together with lists to date of the awards. In the present publication the awards of the American Academy only, from the date of its foundation to the end of 1920, are given in chronological order. The first award of the Rumford Premium was made in 1839 to "Robert Hare, of Philadelphia, for his invention of the compound or oxyhydrogen blowpipe," and the last recorded, that of 1920, to "Irving Langmuir, of Schenectady, for his researches on thermionic and allied phenomena." The grants for research from the Rumford Fund extend from 1832 to 1920, and the names of many illustrious men of science appear in the list. The pamphlet concludes with an alphabetical list of recipients of the grant.

IN his Croonian lecture on "Release of Function in the Nervous System" (delivered at the Royal Society on May 5, and now published in the society's Proceedings) Dr. Henry Head has given an illuminating summary of his great work in neurology. Dr. Head is the successor of Hughlings Jackson, and the fundamental principle on which his investigations are based is the rule laid down by Jackson more than fifty years ago that "destructive lesions never cause positive effects, but induce a negative condition which permits positive symptoms to appear." In other words, in his interpretations of the clinical significance of the symptoms of injuries involving the central nervous system he has avoided the fashionable and misleading device of accepting all active manifestations of disease as the effects of irritation. "Removal of a dominant neural mechanism permits the activity

of lower centres to appear. These unfettered manifestations are not fortuitous pathological states, but represent that part of a complex reaction which still remains active." It is impossible within the scope of a note such as this to give any adequate idea of a lecture that is itself the highly condensed summary of thirty years' research into problems of great inherent complexity which have become obscured by erroneous methods of interpretation. Dr. Head's work is a brilliant example of the successful application of the true scientific method in clinical medicine, and is complementary to Prof. Sherrington's investigation of the same sort of problems by the experimental method. Much as their researches are misunderstood and however inadequate the appreciation of their worth may be at the present time, there can be no doubt that in the future Head's and Sherrington's work will be known as the outstanding achievement of British science in neurology and the borderland between neurology and psychology. Dr. Head's contribution to this great advance in knowledge is well set forth in his Croonian lecture.

DR. J. RITCHIE contributes to the *Scottish Naturalist* (May–June, 1921) an interesting analysis of the status of the walrus as a member of the British fauna. He supposes that when the polar ice sheet extended much further south, and during its retreat in the late Ice age, the walrus was a regular inhabitant of British seas, and the evidence, though scanty, goes to show that even down to the sixteenth century it was regularly hunted by the islanders of Scotland for commercial purposes. In an analysis of the twenty-four records since 1800 Dr. Ritchie concludes that a change in its status has occurred, and that it is now only a straggler which chance conditions bring occasionally to our shores. Summer is predominantly the season for its visits, and its appearance in British waters is associated with the breaking-up of the winter ice of the Arctic and its gradual drift to sea under the influence of ocean currents and winds. The majority appear to have travelled from a westerly source towards Iceland, brought there by unusual developments of the Greenland-Iceland-Faroe oceanic circulation. A marked decrease in the numbers observed in British waters occurred after 1870, which Dr. Ritchie attributes to the activities of seal-hunters about that period in clearing the more southerly breeding-grounds off Greenland of their stocks.

IN an interesting article on "Snakes that Inflate" in *Natural History* (vol. 21, No. 2), Mr. G. K. Noble discusses the significance of an aggressive warning attitude assumed by certain snakes when disturbed. In *Spilotes pullatus mexicanus*, a harmless snake, he found that the animal, when uneasy or in a highly nervous state, inflated its neck and vibrated its tail, recalling the warning attitudes of cobras on one hand and of rattlesnakes on the other. The mechanism by which the snake is able to inflate itself is simple. The dorsal membrane of the trachea is an enormously expanded sheet capable of great distension, and the snake simply fills its lungs with air, closes the glottis, and, by means of its powerful body muscles, forces the air into the trachea, which then becomes distended. Mr. Noble finds this habit developed in many species of snakes, generally harmless, belonging to quite separate families, and the mechanism is in all cases the same. He regards the character as having arisen independently in a number of unrelated groups of snakes, and as an impressive example of parallelism in adaptation. Similar evidence is noted about the habit of vibrating the tail when disturbed. While admitting that both phenomena may be called warning attitudes, he suggests that both actions may be simply manifestations of an uncomfortable nervous state produced by the presence of some disturbing factor in the environment.

A RAIN map of Australia for the year 1920 has been issued by Mr. H. A. Hunt, Commonwealth Meteorologist. The distribution of rainfall in different parts of Australia is shown graphically for the year, and on the reverse side there is a rainfall map for each of the twelve months. For comparison a small map of Australia is given for each year from 1908 to 1920, which shows the percentage of the area with the rainfall above the average. In 1918 only 23 per cent., and in 1919 only 13 per cent., of the area received more than average rainfall; in 1920, however, on 54 per cent. of the area rainfall was above the average. The single sheet is admirably arranged, and the large amount of data in no way overcrowded. It affords a specimen for any rainfall organisation, and a similar sheet would be greatly appreciated by those interested in rainfall distribution in any country. A summary table and notes on the 1920 map are given. It is stated that the year will be memorable on account of the complete change from unpromising weather conditions during the early months to widespread rains in the latter half. The long drought which had prevailed over central and eastern Australia since the early part of 1918 was completely broken up. The splendid rains during the greater part of the agricultural season, April to October, are said to have resulted in one of the best harvests on record all through the wheat-belt. Brief summaries of the rainfall distribution in 1920 are given for each State. At many stations in South Australia 1920 was the wettest year on record.

MR. E. T. QUAYLE (Proc. R. Soc. Victoria, new ser., vol. 33, pp. 115–32, 1921) has issued an optimistic estimate of the beneficial effects on the climate and rainfall of Victoria and of the southern districts of New South Wales that may be expected from irrigation. He illustrates the fact that the leeward shores of wide arms of the sea have usually a higher rainfall than the windward shores by reference to the records from Spencer Gulf and Port Phillip. He considers that the extension of irrigation in the Murray valley may have the same effect as if the irrigated region were covered by an arm of the sea. He claims that higher evaporation will increase not only the local rainfall, but also that on the mountains in which the Murray River and its tributaries take their rise, so that the rivers will be magnified, and the benefits

to the climate and the country will be so great and varied that "it would be hard to put any limits" on them. The evidence for these estimates is not convincing. That the influence of irrigation must be to increase the precipitation to some extent is not likely to be questioned; but the extent of the influence is uncertain. Mr. Quayle claims that irrigation has increased the rainfall during the past ten years. This period is, however, too short to give any trustworthy evidence of a permanent change, as are also the statistics quoted from 1885. Similar predictions have been made from other areas where extended irrigation happened to coincide with the wetter part of a climatic cycle. The absence of any increase of rainfall beside the irrigated areas of Egypt suggests caution in reliance on records for so short a period as are available in Victoria, especially as it is in a situation where irregular long-period variations in weather are so likely to occur.

MESSRS. LONGMANS AND CO. are to publish in the autumn vols. 1 and 2 of "A Comprehensive Treatise on Inorganic and Theoretical Chemistry," by Dr. J. W. Mellor, which work will consist of six volumes in all. Vol. 1 will to a large extent be historical and introductory, and give a general survey of chemical research and discovery from the earliest times to the present day. This volume will also deal in detail with hydrogen and oxygen in their many forms and compounds. Vol. 2 will cover the whole range of the following elements and a systematic range of related compounds:—Fluorine, chlorine, bromine, iodine, lithium, sodium, potassium, rubidium, and cæsium. The same publishers also promise a new edition—the fourth—of Dr. E. J. Russell's "Soil Conditions and Plant Growth."

MESSRS. W. HEFFER AND SONS, LTD., Cambridge, have in the press "Notes and Examples in the Theory of Heat Engines," by J. Case. The book is intended as a companion to lectures to enable the student to see at a glance the essential points of the subject and to help him with his revision for examinations. The engineer who has to deal with the elementary thermodynamics of steam and other heat engines should find the work of value, as all the important formulæ he may require are printed in heavy type and easily found.

A USEFUL catalogue (No. 89, August) of nearly two thousand second-hand books dealing with entomology, ornithology, general zoology, and botany has just been issued by Messrs. Dulau and Co., Ltd., 34 Margaret Street, W.1. It is obtainable upon application.

Our Astronomical Column.

LARGE METEORS.—Mr. W. F. Denning writes:—"A considerable number of unusually brilliant meteors were observed at about the period of the recent Perseid display. On August 11 at 9h. 28m. G.M.T. a very fine object was recorded at Bristol and at various places in South Wales. Near the end of its flight it illuminated the firmament so strongly that people at first mistook it for a flash of lightning. The meteor fell from a height of from 75 to 53 miles, and its path was over the region from Swansea to Barnstaple Bay. It was directed from the usual radiant point in Perseus.

"Another meteoric fireball appeared at 10h. 42m. G.M.T. on the same night. It passed over Berkshire at a height descending from 78 to 45 miles at a velocity of about 30 miles per second. This was also a Perseid, and it was observed from Bristol and Wimborne, Dorset.

"Another fireball was seen on August 15 at 9h. 46m. G.M.T. As viewed from Nuneaton, Warwickshire, by the Rev. Ivo Carr-Gregg, it crossed α Ursæ Majoris in a direction from Serpens and Scorpio. Only one observation has come to hand of the latter object, and a duplicate record of the path would supply the necessary data for computation of the fireball's real course in the air."

ANCIENT ECLIPSES.—Dr. J. K. Fotheringham was the Halley lecturer this year, and chose ancient eclipses as his subject. He noted the appropriateness of the choice, since Dr. Halley had been the first to announce the secular acceleration of the moon's motion from his study of the old eclipses.

Dr. Fotheringham expresses surprise that Dr. E. W. Brown in his new tables of the moon adopts the value 6″ per century which arises from the change in the eccentricity of the earth's orbit; the ancient eclipses, as discussed by Drs. Fotheringham and Cowell (misprinted "Cavell" on p. 25 of the lecture), make it tolerably certain that the actual value is 4″ or 5″ greater, and that the sun has also an acceleration of at least 1·5″, presumably arising from a retardation of the earth's rotation.

One of the most definite records of eclipses is that of Thucydides (August 3, 431 B.C.); it has hitherto been inferred that, since "some stars became visible," Athens must have been close to the central line, but Dr. Fotheringham shows that a magnitude of 10½ digits suffices. In the eclipse of last April Venus, Mercury, Capella, Vega, Arcturus, and Aldebaran were seen at places in the British Isles where the magnitude did not exceed 10·6.

In addition to their application to astronomy, the lecture shows the great value of several of these eclipses from the chronological point of view; in fact, their combination with Ptolemy's and the Assyrian eponym canons determines dates back to the tenth century B.C.

CALENDAR DATES IN METEOROLOGY.—M. Jean Mascart contributes a paper to *Comptes rendus* of July 11 in which he points out the desirability of dating meteorological phenomena by the sun's longitude in place of the calendar date. Owing to the odd fraction of a day that occurs in the length of the tropical year, the same calendar date corresponds with different solar longitudes. There is, of course, no question that M. Mascart's contention is sound in theory; but since it is almost inevitable that the observations should be taken at fixed hours of the solar day, it would involve considerably more labour to re-arrange them in accordance with the sun's longitude, and it is very doubtful whether there would be any adequate compensation for such extra work.

Agricultural Research at Rothamsted.

THE Lawes Agricultural Trust has recently issued a useful index to the activities of the Director of Rothamsted and his colleagues. The index is described as a "Report" for 1918–20; but within its 86 octavo pages it would be impossible to report adequately on the work now in progress. The pamphlet states the aims of Rothamsted, indicates the methods adopted in its scientific work, and mentions the sources to which those interested in the investigations may go for fuller information.

The aims of Rothamsted have not changed, but in recent years the soil and fertiliser problems investigated by Lawes and Gilbert have been studied in new aspects; the Rothamsted team now numbers nearly forty scientific workers, and includes chemists, physicists, biologists, pathologists, and statisticians. Whereas formerly the chief work might best have been described as the study of the soil, stress is now laid rather on crop production. No possible means of throwing light on the reasons for high or low yield is neglected. The physical condition of the soil; the factors which influence the supply of water to the plant or determine the mechanical effort required in tillage; the character of the soil population and the possibility of control; the gains and losses of fertilising substances; the precise quantities of fertilisers which different crops require; the effects on production of competition within the soil and between the individual plants of a crop, or between cultivated plants and weeds; the effects of overcrowding on the aerial development of crops; the extent to which attacks of insects and fungi reduce the yield; the influence of the year's weather and the cumulative effect of several favourable or unfavourable seasons—all these questions and many ancillary subjects are now engaging attention.

With so many subjects under investigation, the methods of work required of the Rothamsted staff offer many contrasts. No contrast is sharper than that which the element of time introduces. A "time" distinction may not have much importance for those interested only in the results of scientific work; but in dealing with such problems as those which Rothamsted tackles, it raises considerations of very practical moment to the Director and his staff. The study of the organisms present in soils has recently engaged much attention. Changes in the soil population were so rapid that little light was thrown on their development by the examination of an occasional sample. For a year, therefore, on every day, counts were made of certain species, and now that the year's results have come in it is found that even more frequent sampling and counting will be necessary. In a building adjoining the laboratory, in which a team of workers has been handling samples and studying the ceaseless changes in these Rothamsted soils for 365 days in succession, without even Christmas Day for holiday, there are other samples, faithfully collected and stored by Lawes and Gilbert year after year for more than half a century, which are now awaiting the time when some chemist will turn to them for aid in unravelling the story of the changes in land in which wheat has been growing continuously since the autumn of 1843!

The fate of these old soil samples suggests that problems are not lacking at Rothamsted. There has been a large increase in the staff in recent years; but with agricultural science—as with its raw material, the soil—intensive cultivation increases output. The results, in a sense, are embarrassing. No sooner is a laboratory ready than its accommodation is exhausted, and the Trustees and Director must find more space or see the problems of their staff condemned to involuntary "pupation." It is understood that the entomological staff has, for some time, been awaiting a new laboratory, and that its construction must be put in hand without delay if a "resting stage" is to be avoided.

Not the least satisfactory feature of the work at Rothamsted is the care and trouble taken by the staff to explain the bearing of its studies. This readiness must have been remarked by many recent visitors, and it is reflected in the admirably clear abstracts which the report contains of the more important of the sixty-one papers published within the past two years. The abstracts are arranged in two groups—scientific and technical. A subject is not necessarily dealt with in each series; frequently publication in one or other form suffices. But nearly all the material embodied in the scientific papers is ultimately used in papers suitable for farmers' journals.

Scientific Research in the United States.[1]

By J. W. WILLIAMSON.

THE two papers referred to below, written by the Chief Physicist of the Bureau of Standards, whose recent death is widely deplored, though dealing only with the question of scientific research as it affects the United States of America, will well repay the careful study, not only of British scientific workers, but also of all British citizens who wish to form a just estimate of the part that scientific research should play in the national economy. In the first of the papers Prof. Rosa set himself to answer the inquiry: "Whether scientific research as carried on by the Federal Government is a luxury or a necessity; whether it is something to be enjoyed when taxes are light, and curtailed when taxes are heavy; or whether it is creative and wealth-producing, and therefore to be increased and developed when expenses are abnormally large and a heavy debt must be liquidated?" In an interesting and informative examination of the national Budget he shows that the appropriations for obligations arising from recent and previous wars and for the War and Navy Departments amount to 92·8 per cent. of the total, public works to 3 per cent., primary Governmental functions to 3·2 per cent., and research, education, and developmental work to 1 per cent.

Prof. Rosa pregnantly observes: "One is led to wonder whether the total burden of taxation would not be lighter if the expenditure for scientific and developmental work were increased; if, for example, it were one dollar per year *per capita* instead of fifty cents." He answers the question by a detailed account of how the fifty cents *per capita* is expended

1 (1) "The Economic Importance of the Scientific Work of the Government." A lecture given before the Washington Academy of Sciences on May 20, 1920. Reprinted from the Journal of the Washington Academy of Sciences, vol. 10, No. 12. By Edward B. Rosa.

(2) "Scientific and Engineering Work of the Government." Reprinted from the February, 1921, issue of *Mechanical Engineering*. By Edward B. Rosa.

and what is accomplished thereby. We have not space to dwell on his review of the work of the various Government Departments included in the classification of "research, education, and developmental work." It embraces the activities of the Agricultural Department, the Geological Survey and the Bureau of Mines, the Bureaux of Standards and of Foreign and Domestic Commerce, the Coast Survey and the Bureau of Fisheries, the Bureau of Labour Statistics, the Woman in Industry Service and the Children's Bureau, Educational Work, the Public Health Service, and co-operation by the Government in Industrial Research and Standardisation. We may note, however, that nearly two-thirds of all the expenditures made under this group of services are for the work of the Agricultural Department.

To the scientific research designed to develop the industries of the country Prof. Rosa refers in more detail. He has no difficulty in showing the necessity and the value of an increased expenditure, wisely applied, in this field. In the course of a summary of his argument he well says: "It is stupid and blind to think that because taxes are heavy we cannot afford to do things intelligently. If a farmer's barn burns down, he would not sell half his supply of seed and fertiliser to buy lumber, and then plant only half a crop. He would, if necessary, borrow money to buy more seed and plant a larger crop than usual in order to increase his income and pay for the new barn more easily. Intelligent research by the Government, in co-operation with the industries, is like seed and fertiliser to a farmer. It stimulates production and increases wealth, and pays for itself many-fold. It is as productive and profitable in peace as in war."

If we put aside the temptation to ask why the barn was not insured against fire, the illustration is apt enough for a world painfully recovering from the ravages of war. But America is not the only country where the superficial economists, appalled by the weight of taxation, begin to economise by cutting down expenditure in the productive services of "research, education, and developmental work." It is a pity that Prof. Rosa's paper will not be read by the "anti-waste" apostles. It is easy to gain a reputation for economy by shouting loudly "We cannot afford it," and difficult to realise that there are some things we cannot afford not to afford.

In his second paper Prof. Rosa usefully supplements his general argument in the first paper by a careful inquiry into the actual expenses of the various departments of bureaux of the Government. He begins by admitting that there is in the mind of the general public a feeling that the scientific work of the Government is not carried on so successfully or so efficiently as it should be, and that it probably costs too much. In order to get an accurate knowledge of Government expenditures and to ascertain how they have increased in recent years, the receipts and expenditures of all departments for the last ten years were analysed. The analysis given by Prof. Rosa is full of interest, and is illustrated by several ingenious diagrams. We have not space to review this analysis, but we may note one conclusion: "The *per capita* cost of the civil side of the Federal Government in 1920 was only a little more than half of what it was in 1910 if measured in commodities or in money of equal purchasing power. During this ten-year period the wealth of the country had greatly expanded, the war had come and gone, the problems of Government had enormously increased, and yet the *per capita* cost of these civil activities measured in commodities had fallen to a little more than one-half. In face of these facts people are saying that the Government is extravagant, inefficient, and overdeveloped." That sort of criticism is not peculiar to the people of America.

Cotton Research in Egypt.

THERE has been for many years a great deal of talk about research work on cotton. The Empire Cotton Growing Committee put research in the forefront of its programme, and it was originally suggested that a research institute should be established in Egypt. About the same time the British Cotton Industry Research Association was established in Manchester, but so far it has not done anything in the way of cotton-growing except to discuss methods of co-operation with the Empire Cotton Growing Committee. The latter has, of course, not been able to do much yet, owing to the time necessarily involved in its reconstruction into the new Empire Cotton Growing Corporation.

In the meantime, the Egyptian Government took its own steps by setting up in May, 1919, a Cotton Research Board, consisting of representatives of all the Departments of the Government which are interested in cotton-growing. A very brief preliminary report was published by the Research Board in March, 1920, and the first annual report embodying a review of the work done up to this date is now before us.[1]

The report proper deals in about fifty pages with the experimental work which has been done on cotton during the year 1920. This work has covered a very wide field, including botanical work on cotton and cotton-breeding (in which selection has apparently played a very much larger part than hybridisation), the selection and propagation of seed by the State domains, and a number of variety tests. Experiments on spacing and on the effect of water on the crop are described, as well as the work done in connection with insect pests, especially the pink boll-worm, and some mycological research. The programme of experimental work for 1921 is also outlined. Much of the work is still unfinished, and certain parts of it will be published by the Departments concerned in other forms as soon as results are available.

The Research Board has, however, very wisely not confined this report to its own work, but has added about 75 pages of reports on special questions considered by the Board, many of these more of an economic than of a purely scientific character, and a number of useful summaries of various publications of the Ministry of Agriculture made within the last few years on subjects affecting cotton. There are also reviews of publications from other sources affecting cotton and some very useful appendices. This supplementary matter deals with such questions of direct economic importance as the development of Pillion cotton in Egypt and its threatened supersession of the superior variety known as Sakel. It also covers the development of Pima cotton in Arizona, U.S.A., which looked for a time as if it might prove a serious rival to Egyptian. On the latter point, however, Egypt has probably derived considerable reassurance from the very marked reduction of the Pima crop this year owing to the fall in prices.

[1] First Annual Report (1920) of the Cotton Research Board, Ministry of Agriculture, Egypt. (Government Publications Office, Cairo.) 10 piastres (2s. 1d.).

Among the publications summarised are two of special importance by outside experts, who were called in by the Egyptian Government to report on their cotton problems within the last few years, namely, Mr. H. A. Ballou, a West Indian entomologist, and Mr. H. Martin Leake, a botanist in the service of the Indian Government. These independent reports have been of great value to those who are following the development of the cotton position in Egypt. The appendices contain some rather disconcerting statistics of the crop, an account of cotton legislation in Egypt during 1920, and a very useful summary of botanical research on cotton carried out in Egypt up to 1918, along with a bibliography of the chief cotton pests of Egypt.

There is always room for difference of opinion as to the scientific value of the results achieved by research work, and no one who knows the difficulties under which scientific workers in Egypt have laboured in the past would expect any very large results in the short time in which the Cotton Research Board has been in existence. These two years have, in fact, been largely spent in preliminary work, and indeed the new research laboratory at Giza was scarcely finished when the report was written. But no one can question the value of such a compendium of a great deal of the work that has been done in the past. The report will form a useful summary for those interested in all the various lines of activity regarding Egyptian cotton.

University and Educational Intelligence.

THE Merchant Venturers' Technical College, which provides and maintains the faculty of engineering in the University of Bristol, has issued a prospectus for the academic year 1921–22. A prominent feature is the "sandwich" scheme, which engineering students have the option of adopting. By this arrangement the course of five years is divided into three periods of ten months each, which are spent at the University, and three periods of fourteen, two, and fourteen months respectively, spent in engineering works. More than twenty well-known engineering firms in Great Britain co-operate with the University for this course, in many cases offering to receive students with reduced, or even without, premium. The scheme provides an opportunity for a thoroughly well-balanced training for the profession.

THE Edinburgh and East of Scotland College of Agriculture has issued a calendar for the year 1921–22, in which a full account of the courses available at the college will be found. The classes are arranged in conjunction with the science faculty of Edinburgh University, and two courses are open to students: (*a*) for the degree in agriculture conferred by Edinburgh University, and (*b*) for the college diploma in agriculture. Part of the course required for the University degree in forestry is also provided, and there are, in addition, a number of classes devoted to horticulture. A novel feature is the five weeks' course provided in January and February of each year for the benefit of farmers and others who cannot attend a full diploma course. The course extends over two years, the first being devoted chiefly to soils, manures, and farm crops, and the second to feeding-stuffs and the management of livestock; in the coming winter the second part of the course will be given. Local farmers co-operate with the staff of the college in investigating new conditions or special problems arising out of their farming operations, and a number of useful papers have already been published dealing with the results obtained.

Calendar of Scientific Pioneers.

September 1, 1648. Marin Mersenne died.—A schoolfellow and friend of Descartes, Mersenne occupied various ecclesiastical appointments, translated Galileo's "Mechanics," experimented on sound, and was one of the group of eminent men whose meetings led to the founding of the Paris Academy of Sciences.

September 2, 1832. Franz Xavier, Baron von Zach, died.—Retiring from the Austrian Army as a colonel, Zach became the first director of the observatory at Seeberg, Gotha. His *Monatliche Correspondenz*, founded in 1800, was the forerunner of Schumacher's *Astronomische Nachrichten*.

September 2, 1836. William Henry died.—Awarded the Copley medal in 1809 for his contributions to chemical literature, Henry experimented on gases and enunciated the law connecting the pressure with the solubility of a gas.

September 2, 1865. Sir William Rowan Hamilton died.—After a remarkable career as a student, during which he wrote mathematical papers of a high order, Hamilton in 1827, at the age of twenty-two, became Andrews professor of astronomy at Dublin. For many years a correspondent of De Morgan, he was, like him, of a speculative mind. He is best known for his "Theory of Systems of Rays," his prediction of conical refraction, his "General Method of Dynamics," and his discovery of quaternions.

September 2, 1883. Cromwell Fleetwood Varley died.—One of three brothers who were all concerned with the early telegraphs, Varley did valuable work in connection with the Atlantic cables. His brother, Samuel Varley, was a pioneer worker on the dynamo.

September 4, 1784. César François Cassini de Thury died.—The third of the five members of the Cassini family who became members of the Paris Academy of Sciences, César Cassini is best known for his trigonometrical survey of France.

September 4, 1852. William Macgillivray died.—Macgillivray in 1841 became professor of natural history at Aberdeen. His "History of Birds" was published in 1837–52.

September 5, 1902. Rudolf Virchow died.—Placed in the foremost rank of pathologists by the publication of his "Cellular Pathology" in 1856, Virchow for many years was director of the Pathological Institute at Berlin. In later life he rendered important services to ethnology, anthropology, and archæology, and as a public man he was instrumental in transforming Berlin from one of the most unwholesome of cities to one of the most healthy. The centenary of his birth occurs on October 13, 1921.

September 5, 1906. Ludwig Boltzmann died.—A distinguished worker in mathematical physics, Boltzmann studied the work of Clausius and Maxwell, and became an authority on the kinetic theory of gases and on thermodynamics. He held chairs at Gratz, Munich, Leipzig, and Vienna.

September 6, 1902. Sir Frederick Augustus Abel, Bart., died.—One of the first pupils of Hofmann at the Royal College of Chemistry, Abel in 1854 became chemist to the War Office, a post he held for thirty-four years. He made valuable researches on gun-cotton, with Dewar invented cordite, and was an authority on petroleum and coal-mine explosions. He served as president of various institutions, and in 1893 was made a baronet.

September 7, 1882. Joseph Liouville died.—An engineer in the Ponts et Chaussées, Liouville resigned his position, devoted himself to the study of mechanics and pure mathematics, and from 1836 to 1874 edited the *Journal de Mathématique*. To Liouville and Regnault Kelvin was much indebted as a student.

E. C. S.

Societies and Academies.

PARIS.

Academy of Sciences, August 16.—M. Léon Guignard in the chair.—L. **Maquenne** and E. **Demoussy**: The respiration of leaves in a vacuum or in atmospheres poor in oxygen. Intracellular respiration and normal respiration, which some authors have viewed as having a common origin, proceed in reality from different causes, and should be regarded as autonomous functions, as much by their internal working as by their influence on the life of the plant.—P. **Vuillemin**: A new parasitic fungus in man, *Glenospora gandavensis*.—C. **Nordmann**: Remark on a recent communication. Further details of the methods of observation in heterochrome stellar photometry.—R. **Ledoux-Lebard** and A. **Dauvillier**: The utilisation of constant electromotive forces in radio-diagnostics.—E. **van Aubel**: The influence of temperature on the viscosity of normal liquids. The formula proposed is

$$\phi = m + n \log (\Theta - t),$$

where ϕ is the fluidity or reciprocal of the viscosity, Θ is the critical temperature of the liquid, and m and n are two constants. As a consequence of this, the increase of fluidity for a given rise of temperature is inversely proportional to $(\Theta - t)$. The validity of the relation proposed is proved by comparing the fluidities calculated from the formula with the experimental data of Thorpe and Rodger, Heydweiller, and Meyer and Mylius.—P. **Woog**: The dimensions of the molecules of the fatty oils and some phenomena of molecular solutions.—H. **Gault** and R. **Weick**: The additive properties of the keto-enolic double linking.—E. **Chatton**: The reversion of scission in ciliated organisms.—E. **Grynfeltt**: The histological process of fatty osteoporosis of traumatic origin.—W. **Koskowski** and E. **Maigre**: The paralysing action of methylene-blue on the parasympathetic nerve-endings.

CAPE TOWN.

Royal Society of South Africa, July 20.—Dr. A. Ogg in the chair.—E. J. **Hamlin**: Some observed results of the effect of sunlight on lead storage cells. A cell exposed to sunlight is 3 per cent. less efficient than a similar cell shielded from the direct rays; the useful life of the cell is diminished by approximately 25 per cent. by the effect of the direct rays of the sun.—E. J. **Hamlin**: The effect of evaporation on the efficiency of lead storage batteries. By using a "topping" of $\frac{1}{2}$ in. of paraffin the amp.-hour efficiency of a battery was increased by 1·7 per cent. This is more economical than "topping" the battery with distilled water to counterbalance the effect of evaporation.—Dr. J. D. F. **Gilchrist**: Note on the pectoral fin of the sole, *Achirus capensis*. The pectoral fin is represented by a small vertical fold of epidermis with rudimentary rays, situated on the body below and concealed by the opercular membrane. It functions as an accessory organ in respiration. Suggestions are made as to how it may have arisen and as to how the characters acquired have become hereditary.

Books Received.

Modern Motor Car Practice. Edited by W. H. Berry. (Oxford Technical Publications.) Pp. xii+582. (London: Henry Frowde and Hodder and Stoughton.) 31*s*. 6*d*. net.

Industrial and Power Alcohol: The Sources, Production, and Denaturing of Alcohol—its Manifold Chemical and Physical Applications in Industries and Manufactures, and its Use as a Fuel for Internal Combustion Engines—Technical, Commercial, and Excise Aspects of the Problem. By Dr. R. C. Farmer. (Pitman's Technical Primer Series.) Pp. x+110. (London: Sir Isaac Pitman and Sons, Ltd.) 2*s*. 6*d*. net.

Historical Eclipses: being the Halley Lecture delivered May 17, 1921. By Dr. J. K. Fotheringham. Pp. 32. (Oxford: At the Clarendon Press.) 2*s*. 6*d*. net.

Die Phylogenese: Fragestellungen zu ihrer exakten Erforschung. By Prof. Bernhard Dürken and Prof. Hans Salfeld. Pp. 59. (Berlin: Gebrüder Borntraeger.) 15 marks.

Sulphur and Sulphur Derivatives. By Dr. H. A. Auden. (Common Commodities and Industries.) Pp. xviii+101. (London: Sir I. Pitman and Sons, Ltd.) 3*s*. net.

Hygiene for Health Visitors, School Nurses and Social Workers. By Dr. C. W. Hutt. Second edition, revised. Pp. xiii+382. (London: Methuen and Co., Ltd.) 12*s*. 6*d*. net.

Etudes sur les Infusoires d'Eau Douce. By Dr. E. Penard. Pp. vi+331. (Genève: Georg et Cie.)

Nedbørіakttagelser i Norge utgitt av det Norske Meteorologiske Institutt. Årgang xxvi., 1920. Pp. xiii+78+45. (Kristiania.) 6 kroner.

The Free-living Unarmored Dinoflagellata. By C. A. Kofoid and Olive Swezy. (Memoirs of the University of California, Vol. 5.) Pp. viii+562+12 plates. (Berkeley, Cal.: University of California Press.)

CONTENTS.

	PAGE
The Census of 1921	1
Indian Silviculture	3
The Works of Cavendish. By T. M. L.	4
Paris Weather Statistics. By W. W. B.	6
Soil and Soil Management. By Dr. E. J. Russell, F.R.S.	7
History and Method of Science. By W. B.	9
Our Bookshelf	9
Letters to the Editor:—	
Ruling Test Plates for Microscopic Objectives: Sharpness of Artificial and Natural Points. (*Illustrated.*)—A. Mallock, F.R.S.	10
Biological Terminology.—Dr. Walter Kidd	11
The "Radiant" Spectrum. (*Illustrated.*)—Prof. C. V. Raman	12
Remarkable July Rainfall at Blue Hill, Mass.—Dr. Alexander McAdie	12
The *Philosophical Magazine*.—Sir Oliver Lodge, F.R.S.	12
The Present Position of the Wave Theory of Light. I. By Dr. R. A. Houstoun	13
The Extent of the Recent Drought. (*With Map*)	15
The Disaster to the Airship R38	17
Fuel Problems and Prospects. By Prof. John W. Cobb	18
The "Proletarisation of Science" in Russia. By Dr. Boris Sokoloff	20
Physical Effects Possibly Produced by Vision observed by Dr. Russ. By Dr. H. Hartridge	22
Obituary:—	
Prof. G. T. Ladd. By Prof. G. Dawes Hicks	23
Notes	25
Our Astronomical Column:—	
Large Meteors	28
Ancient Eclipses	28
Calendar Dates in Meteorology	28
Agricultural Research at Rothamsted	29
Scientific Research in the United States. By J. W. Williamson	29
Cotton Research in Egypt	30
University and Educational Intelligence	31
Calendar of Scientific Pioneers	31
Societies and Academies	32
Books Received	32

NATURE

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The British Association.

THIS year's meeting of the British Association in Edinburgh will make, we believe, the beginning of a new epoch in the history of the Association. About a year ago it was pointed out in the *Times*, as well as in our own columns, that conditions are now different from what they were when the Association was founded in 1831, and that for such a body to develop it must adapt itself to the changed circumstances. The Council, in a spirit which should be characteristic of all scientific bodies, was not slow to recognise this need, and a meeting of representatives of all sections was summoned early in this year to consider what changes might appropriately be introduced now or contemplated in the near future. As a result, several departures from custom have been made, and will be followed at the Edinburgh meeting. The addresses of presidents of sections have hitherto been delivered usually on the day following the inaugural meeting, but this year they will be given at different times—those of Sections B, C, D, E, and I on Thursday; of Sections A, F, G, J, and K on Friday; and of Sections L and M on Monday. This will give members of the Association an opportunity of listening to several addresses if they wish. Some of the addresses will also be used to open discussions, this again being a new departure. Joint discussions between two or more sections are not a new feature, but particular prominence is given to them in this year's programme, and it is hoped that they will become increasingly important in future years.

Such changes as these may be said to mark the acceptance of the view that many members of the Association attend the annual meetings, not to listen to papers on their own subjects, but to become acquainted with the chief developments in other subjects. The Association has no *raison d'être* if it resolves itself into a series of meetings of specialised sections having no communication with each other. If that were its function, it could be satisfied by arranging for simultaneous annual meetings of the physical, chemical, geological, zoological, and other scientific societies at selected provincial centres. A far better purpose is served by regarding a meeting of the Association as an occasion for widening interest in scientific work generally, not only among those actively engaged in it, but also among the general public. Opportunity must, of course, be provided for workers in particular fields to exchange views with one another, but the main idea should be to deal with lines of advance in which large groups of members are interested, and these should be presented in such a way as to be intelligible to a general scientific assembly—as they are, for example, at a Friday evening discourse at the Royal Institution.

The number of sections is unimportant, provided only that separate rooms can be found for them and that they represent actual groups of workers in specific fields. There might, if necessary, be twenty sections, in each of which a dozen or more active investigators sat around a table and discussed their own special problems, but in addition there should be, on each day of the meeting, two or three joint conferences in which outstanding points of progressive scientific knowledge are displayed for the benefit of all members, so that biologists may learn what astronomers, physicists, and chemists are doing for the advancement of science, and in their turn enlighten workers in other domains of natural knowledge. The evening discourses do this to some extent, and the joint discussions also carry out the idea. What we suggest is that the Association should continue to develop these lines of wide appeal in order to extend the ground of common understanding.

So far we have referred only to the interests of the members themselves, but the Association has also a duty to the general community. It meets

year by year in different parts of the kingdom in order to direct attention to scientific work and stimulate local effort and support. Only a relatively small proportion of the population of any centre will become members, but a large proportion can appreciate the spirit and service of science and understand the value of scientific knowledge and method in the conduct of provincial and national affairs. The Citizens' Lectures were instituted by the Association for this purpose, and it would be worth while to arrange for the delivery of a couple of these at, say, five o'clock in the afternoon, in addition to the usual evening lectures. Whatever is done to create interest and belief in scientific aims and work among the general public is to the benefit of science, and it is the privilege of the Association to fulfil this function.

An organisation which is approaching the centenary of its foundation cannot readily be modified to make it fit new conditions of vitality, yet the Association is re-shaping itself, and is thus making itself strong to survive for many years yet as the annual Parliament of science in these islands. The Edinburgh meeting promises to be a memorable event in a long and worthy record.

Science in the Middle Ages.

Mediaeval Contributions to Modern Civilisation: A Series of Lectures delivered at King's College, University of London. Edited by Prof. F. J. C. Hearnshaw. With a preface by Ernest Barker. Pp. 268. (London and Sydney: George G. Harrap and Co., Ltd., 1921.) 10*s.* 6*d.* net.

PROF. HEARNSHAW has produced a volume of a valuable type which is happily becoming more and more common. It is a composite book, written mainly by professors at King's College, where it was given as lectures last winter, and the various chapters hang more or less closely together as an account of the debt which the modern world owes to the Middle Ages. This is a conception of history which has gained ground in recent years, and is specially connected with the name of Benedetto Croce. We are coming to see that, as history is a living thing, and the present nothing but the realisation of the past, that part of the past deserves our most serious attention of which we can say with most assurance that it lives and moves in and around us to-day.

Prof. Hearnshaw has applied this conception to the work of the Middle Ages—*i.e.* to the millennium lying, broadly speaking, between the fifth and the fifteenth centuries of the Christian era. He has selected writers who deal with religion, philosophy, science, art, poetry, education, society, economics, and politics. The range is comprehensive. One feels that the choice of contributors might with advantage have been somewhat more comprehensive also. One would have welcomed Dr. A. J. Carlyle on the political theories and political activities of the Middle Ages, and no one would have spoken with more acceptance than Prof. W. V. Ker on the literary aspect of the period, though Sir Israel Gollancz has, of course, treated the English contribution with his usual mastery. The editor has, in fact, adhered a little too closely to the staff of his own college. But we are deeply grateful for what he has given us, and in particular for the two studies on the art and science of the Middle Ages by Dr. Percy Dearmer and Dr. Charles Singer. The latter is one of those happily added from outside to the King's College team, and his contribution specially concerns the readers of NATURE.

It is perhaps strange that the essay on "Science" in the medieval world—the department of human thought in which unquestionably the Middle Ages added least to modern civilisation—should stand out so prominently in this volume as a model of learning well arranged, judgment soundly exercised, and progress clearly exhibited. Yet this is so, and Dr. Singer's paper appears to us worthy of some slight enlargement and publication as a separate work.

He strikes the right keynote within the first four pages. "Medievalism," from the point of view of science, "was a slow process by which the human mind, without consciously increasing the stock of phenomenal knowledge, sank slowly into an increasing ineptitude." It reached a nadir about the tenth century, and after this may be discerned a slow ascent; but the date for the end of medieval and the birth of modern science is fixed by the point when men interested in phenomena, and especially physicists, began to look to the future rather than to the past. The essential bases of the new movement, which became definite towards the middle of the sixteenth century, are hope in mankind and the idea of progress. The medieval period is the thousand years which preceded this and followed the downfall of the Western Empire.

Dr. Singer maps out this millennium admirably in the chronological table which concludes the essay. There was first the "Dark Age" proper, extending from the fifth century to the end of the ninth, from Martianus Capella to Erigena. Then came the intermediate and transitional age of

Arab influence, from the beginning of the tenth to the latter part of the twelfth century; and three centuries of the Scholastics form the last division. The salient characteristics of each division and the leading figures are clearly brought out. Specially notable is the lively picture of the travelling scholar from the West who gets in touch with Arab learning through some Jewish interpreter in a back street of Toledo; and on the side of theory due emphasis is laid on the cardinal doctrine of medieval science, the correlation of the macrocosm and the microcosm, and the enforcement of this by Arabian astrology.

The whole essay is valuable and deserves careful study. The original scientific work of Albertus Magnus receives full credit, though Stadler's new text of one work, the "De Animalibus," was still inaccessible when the book was published. There is an excellent short summary of Roger Bacon's achievements, and Nicolas of Cusa (1401–64) is recorded as the first biological experimenter of modern times, Helmont's experiment on a growing plant, showing that it absorbs something of weight from the air, being due to him.

If we must record a difference from Dr. Singer, it is one of emphasis rather than one of opinion or of fact. He appears to us to exaggerate somewhat the breach with the classical past which the new thought at the end of the medieval period involves. The difference is due mainly to the fact that as a biologist he is struck more by the mass of new and accurate observation which the modern biologist introduced, and less by the continuity of abstract reasoning which mathematical and astronomical science inherited from the Greeks.

Plantation Rubber Research.

Plantation Rubber and the Testing of Rubber. By Dr. G. Stafford Whitby. (Monographs on Industrial Chemistry.) Pp. xvi+559+8 plates. (London: Longmans, Green, and Co., 1920.) 28*s*. net.

THE general editor of this well-known series refers in his introduction to the extraordinary development which the applications of chemistry have experienced during the last four or five decades. In the case of the rubber industry the development is even more recent. Practically the whole of the facts dealt with in Prof. Whitby's book have been discovered within the last fifteen years, and with few exceptions the application of a knowledge of the chemistry of rubber to the industry may also be said to date from the introduction of plantation rubber. Previous to 1905 publications dealing with rubber were few and far between. With one outstanding exception, namely, C. O. Weber's "Chemistry of India Rubber" (1902), there was no text-book dealing with the subject from a theoretical or scientific point of view. The student at that time could make himself familiar with practically all that was either known or surmised by a study of Weber's treatise, and although many of the ingenious suggestions put forward by Weber have had to be abandoned, the book is one that can still be read with profit.

With the inception and development of plantation rubber several chemists began to take an interest in the study of this material, and from time to time other text-books have appeared. Whereas Weber was able to cover the whole field, including manufacturing technique and chemical analysis, in three hundred pages, many later authors have restricted themselves to special branches of the subject. Prof. Whitby has done this, and although he has dealt neither with manufacturing technique nor with analysis, his book runs to some five hundred pages. The title, if cumbersome, is certainly descriptive of the contents, and the book falls naturally into two parts, the first dealing with the preparation and properties of plantation rubber and the second with the physical properties of vulcanised rubber and the interpretation of results obtained in terms of "quality." The first section presents an exact and up-to-date account of the facts and theories underlying the preparation of plantation rubber and a description of the technique as at present in vogue on the best plantations in the East. Such a task could be attempted only by one who has actually carried out experimental work on a plantation and controlled the preparation of rubber. Prof. Whitby had unique opportunities for observation and research, and he has made the most of them. Coming home after some years in the East, he has been able to follow up his plantation work with laboratory studies particularly directed to vulcanisation problems and their elucidation. Consequently the second part of the book presents as thorough and complete a review of the subject as the first.

In the early days of plantation rubber the planter naturally looked to the rubber manufacturer at home for information and advice as to the best form in which to market his product. But the majority of manufacturers did little beyond pointing out that "fine hard Para" was the best rubber, and should form the ideal of the planter's aims. The tedious and primitive process of the Amazon, however, was not suited to plantation requirements; so, having tested vari-

ous coagulants and found acetic acid the most suitable, the planting industry eventually settled down to the production of rubber of two types: (1) washed coagulum, air-dried in the form commonly known as pale crêpe; and (2) surface-washed sheet rubber dried in a smoke-house, the so-called smoked sheet. Faced with these alternatives, the manufacturers were still unwilling or possibly unable to give the planter advice. Some could use only sheet, others only crêpe, yet from both varieties very good motor tyres were made and exhibited at the last rubber exhibition in 1914. Any lack of information or advice from the manufacturers was amply compensated for by the brokers and dealers. These gentlemen supplied abundant criticisms of surface defects and other minor details which have kept planters busy in their factories and the local chemists in their laboratories.

In spite, however, of the time thus occupied, a very considerable amount of scientific work dealing with vulcanisation and the chemical and physical properties of rubber has been accomplished. Prof. Whitby's book is a significant record of the research work carried out on behalf of the planting community. With one or two exceptions, our whole knowledge of the subjects treated rests on the results of such researches. The remainder of the book is concerned with the more purely physical researches on the properties of vulcanised rubber, for which we are indebted to the academic physicists. This is a novel feature, and comprises the first summary of the subject to be published.

The technical aspect of rubber vulcanisation is dealt with by the author in chap. 16. This is perhaps the one chapter in the book which might with advantage have been extended. It is true that our knowledge in this direction is very limited, for reasons already given, but the subject-matter does not include references to some of the more recently published work. It might with advantage have included an account of work on organic and inorganic "accelerators," or vulcanisation catalysts, and cognate subjects, with particular reference to the fast-curing types of plantation rubber in which the "natural accelerators" take the place of the synthetic products which would otherwise have been added by the manufacturer. In this chapter, and indeed throughout the book, the author has succeeded in preserving a detached and impartial attitude when commenting on published results. He has examined each thesis with care, and expressed his reasoned conclusions with moderation.

The book contains a mass of information—in fact, practically everything of importance that is known on the subject—and while it is put together systematically, it is no mere catalogue of facts and theories. One occasionally meets with an awkwardly worded sentence, but the meaning is usually clear. A few instances taken at random may be quoted. The word "breaking length" appears to be used in the sense of final length, whereas in other industries the expression has a totally different meaning. Hollow mixing rollers are usually provided with a single inlet or outlet, which serves for either steam or water; they are not provided internally with separate pipes for each. The "thickness" of a ring referred to on p. 288 is more correctly described as the width, for if the ring is considered as a short tube, the thickness would correspond to the thickness of the wall of the tube.

The author has dealt with a subject which is in a state of rapid development, and considerable skill must have been required to incorporate the new material appearing during compilation. This may account in part for the frequency of footnotes of considerable length, some of which might with advantage have been included in the text. We have noticed a few inaccuracies and misprints; for instance, "clippings," "modal," "centrifiguating," "Euphoria," and "laticometer." The book is provided throughout with copious references and an excellent bibliography which will be found of great value. H. P. S.

Aeronautics.

(1) *Aviation: Theoretico-Practical Text-book for Students.* By B. M. Carmina. Pp. ix+172. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1919.) 11*s.* net.

(2) *The Theory and Practice of Aeroplane Design.* By S. T. G. Andrews and S. F. Benson. (The Directly-Useful Technical Series.) Pp. xii+454. (London: Chapman and Hall, Ltd., 1920.) 15*s.* 6*d.* net.

(3) *Aeroplane Structures.* By A. J. S. Pippard and Capt. J. L. Pritchard. With an introduction by L. Bairstow. Pp. xiii+359+21 plates. (London: Longmans, Green, and Co., 1919.) 21*s.* net.

(1) THERE is certainly room for a good elementary treatise on the aeroplane, written for young students who have only a moderate equipment of mathematical knowledge, and whose acquaintance with mechanics is limited to the fundamental principles and their immediate applications. Mr. Carmina had an obvious gap to fill, but one must unhesitatingly declare that he has failed to take advantage of the opportunity.

The programme the author sets himself is very suitable, there being chapters on the theory of flight, aeroplane construction, rigging, propellers and maintenance, while an appendix professes to deal with aerodynamical formulæ and calculations. The general descriptions are passable, and evidently the author has had practical experience, but the theoretical side of the book is lamentable, and renders the whole work quite unfit to be called a "text-book."

The account of stability makes one wonder whether there should not be some censorship over scientific publications. Thus the author decrees, without any reference to the shape of a body, that "in this state (viz. of neutral equilibrium) the center of gravity of the body is at its center." He declares the best form of equilibrium to be the neutral state. Apparently, stability is the next best thing. On propellers the author announces: "Propellers and mystery are synonymous. In our Year of Grace 1919, nobody knows exactly what a propeller is"; yet seventeen pages follow to elucidate this mystery. One is pleased to be able to say that the chapter on "flight hints" is quite interesting.

"Aerodynamical formulæ and calculations," in the form of an appendix, consists of a lecture delivered so far back as 1911. After the sort of sneers at mathematicians usual with a certain class of people who do not understand mathematics, the author gives some hopelessly inadequate formulæ which might have passed muster in the dark middle ages of aviation, but are certainly unfit as a statement of post-war knowledge. The climax of the book is reached, however, in the "definitions." Algebra is "defined," and a treatise on algebra follows which occupies four pages! The metric system is described as resting on a "natural and invariable standard," the metre being given as 30·37 in., and the litre as 1·0567 quarts. Momentum is defined as the "force of motion acquired by a moving body by reason of the continuance of its motion." Trigonometry is "defined," and then follows a treatise on trigonometry, complete with tables, in three pages! One can only regret that the author did not make sure about his mathematics and mechanics before he wrote the book.

(2) Messrs. Andrew and Benson's contribution to the "Directly-Useful" technical series of books issued by Messrs.. Chapman and Hall deals with aeroplane design, largely from the aerodynamical point of view, but also from the structural. After two general chapters on the fundamental principles of aeroplane design and on the materials available for the purpose, the authors give a detailed account of the properties of aerofoils, with carefully compiled data in tabular and graphical form, of the kind made familiar by the publications of the aeronautics department of the National Physical Laboratory. This is followed by the theory of stresses and strains in struts and rods which is applied to wing-structures for monoplanes, biplanes, etc., in some detail, with a number of numerical illustrations. The aerodynamics of stream-line bodies and struts comes next, followed by chapters on the design of the fuselage and chassis, both aerodynamically and structurally. There is a good chapter on the design of airscrews, including a brief account of the stresses on an airscrew. As introductory to the design of control surfaces, the authors give the usual kind of treatment of the theory of stability, with an account of the different resistance derivatives and numerical applications to various kinds of machines. The chapter on performance includes the instruments used in machines, and this is followed by two interesting chapters on the general lay-out of machines and on the trend of aeroplane design.

The book is clear, accurate, and profusely illustrated by more than 300 excellent plates and diagrams. While not differing widely in matter and arrangement from other books already published, Messrs. Andrew and Benson's book, which is quite elementary in places, can be safely recommended as an easy and not too mathematical statement of our knowledge of the aeroplane in so far as this knowledge bears on the problem of design.

(3) Messrs. Pippard and Pritchard have produced a thoroughly trustworthy treatise, based to a large extent on their personal "experience during the war while engaged in the work of supervising experimental designs from the standpoint of structural strength." The book is not merely a statement of results; it contains a competent treatment of the subject from the theoretical point of view, and the student is not left wondering how results quoted are to be justified mathematically and mechanically, a fault that mars so many of the books on aeronautics.

After a statement of the nature of the problem dealt with in the book, the authors give a brief account of the mechanics of flight and then proceed to a description of the structure of an aeroplane in general and in detail. Chapters follow on the evolutions of an aeroplane in flight, with the consequent loads that the various parts have to carry during and immediately after such evolutions. The subject having been thus introduced, the authors then deal with the elementary theory of elasticity, framed structures from the graphical

point of view, the calculation of centres of gravity and moments of inertia, leading up to a detailed treatment of the theory and calculation of bending moments, shear forces and stresses in beams under various conditions of loading and of support. The application to the aeroplane then follows, the forces on the main plane structure, the fuselage, and the control surfaces, in flight and on landing, being considered in turn. A chapter of particular interest is that on the partially disabled aeroplane. Questions of detail in design are dealt with next, followed by an account of the methods of testing.

From the mathematical and mechanical point of view the chapter on the "principle of least work" deserves special attention. The principle is a statement of the fact that for a structure in stable equilibrium the work function is a minimum, and the authors show how it can be used "to find the stresses in structures which are statically indeterminate—*i.e.* in structures with too many members."

There are three appendices. The first consists of tables of values of what are called Berry functions. As Prof. Bairstow puts it in his preface, "the most accurate method of calculation of spar stresses yet known is due to Mr. Arthur Berry, . . . and by the help of a number of tables which he compiled the work is not unduly laborious." The functions thus tabulated are:—

$$f(\theta)=6(2\theta\operatorname{cosec}2\theta-1)/(2\theta)^2,\quad \phi(\theta)=3(1-2\theta\cot 2\theta)/(2\theta)^2,$$
$$\psi(\theta)=3(\tan\theta-\theta)/\theta^3;$$
$$F(\theta)=6(1-2\theta\operatorname{cosech}2\theta)/(2\theta)^2,\ \Phi(\theta)=3(2\theta\coth 2\theta-1)/(2\theta)^2,$$
$$\Psi(\theta)=3(\theta-\tanh\theta)/\theta^3.$$

Values are also given for $\tanh\theta$. The second appendix reproduces the "materials specifications" issued by the Air Ministry from time to time, while appendix 3 gives the aerodynamical characteristics of various types of aerofoils.

The book is illustrated by twenty-one plates and 259 diagrams. It is an authoritative account of one of the most important aspects of aeroplane design, as well as of aeroplane theory, and will no doubt be the standard work on the subject in English for some considerable time.

S. BRODETSKY.

A Text-book on Oceanography.

A Text-book of Oceanography. By Dr. J. T. Jenkins. Pp. x+206. (London: Constable and Co., Ltd., 1921.) 15*s.*

"THE higher forms of schools, teachers in training, and students attending schools of Geography in the Universities" constitute the audience for whom this book is intended. It is a short summary of the more salient results of physical oceanography, and as such it is, on the whole, a well-balanced statement. It is based on the well-known "Handbuch der Ozeanographie" by Dr. Otto Krümmel. Dr. Jenkins follows the same line of treatment, and borrows from the matter of this authoritative work.

As Dr. Krümmel's book was published in 1907, the work before us neglects matters of much interest that have been investigated since that date. Thus there is comparatively little about hydrobiological phenomena, and the modern ionic theory of solution is not dealt with in spite of the great importance of recent work. The section on the composition of sea-water suffers by this omission. It is not quite accurate to say that "radio-activity is not observable in sea-water," and the young student may find some difficulty in the statement made that, "if the electric conductivity of pure water be taken as *nil*, then that of sea-water at 0° C. and of salinity 35 per mille will be 0·0293 ohms."

The section on the tides is badly done. There are several misprints in the expressions given for the tidal potential, and these may trouble inexperienced readers. Moreover, it is stated that "the numerous calculations necessary in the harmonic analysis can be performed by a machine—the tidal predictor." There are said to be four of these machines in existence, and that one of them belongs to the British Government. This does us too much credit: the British machine is privately owned, and there are really more than four in existence. As a matter of fact, the British tide-tables published by the Admiralty are also privately computed.

Is it correct to say that the form of waves is trochoidal? Cold surface water does not sink down at the Poles because of its greater density, but flows superficially and in a southerly direction for a considerable distance because of its low salinity before it sinks to the bottom. Recent work by the Scottish Fishery Board shows that the direction of flow of water in the north-west part of the North Sea may take the reverse direction to that represented on p. 182.

Apart from such mistakes, and in spite of a certain lack of appreciation on the part of the author of the spirit and method of modern marine research, the book is sure to be useful to just the kinds of students mentioned in the preface. But it is too small (and dear), and it is badly illustrated. The figures are all borrowed, and the sources of many of them are unacknowledged. From the point of view of the student the index is bad.

J. J.

Our Bookshelf.

Catalogue of the Fossil Bryozoa (Polyzoa) in the Department of Geology, British Museum (Natural History). The Cretaceous Bryozoa (Polyzoa). Vol. 3. *The Cribrimorphs.*—Part 1. By Dr. W. D. Lang. Pp. 12+cx+269+8 plates. (London: British Museum (Natural History), 1921.) 30*s.*

THOUGH the price must at present remain high, the issue of this volume is, we hope, a sign that research in our public scientific institutions will still find means of publication. Museums and geological surveys flourish largely by interchange of ideas, and the volumes issued by smaller countries—Finland is now a notable example, and Poland has come into the field—may react on those who would restrict the official output of Britain to works of economic value. Dr. Lang here presents us with careful descriptions of co-ordinated fossil species; but his biological introduction shows how he bears in mind their history as living things. He finds no obvious utility in the mode in which bryozoa have deposited calcium carbonate in a variety of artistic forms, and he regards such deposition, even in molluscs, as a mode of getting rid of material not required by the living tissue. He admits a protective result in many cases, but not a protective intensification through natural selection. In bryozoa the details of skeletal structure seem to him "due to the necessity of piling up superfluous calcium carbonate where it least interferes with the organism's bionomy." We are glad to note that this work is produced on good paper in harmony with its many predecessors.

G. A. J. C.

Critical Microscopy: How to Get the Best out of the Microscope. By Dr. A. C. Coles. Pp. viii+100+3 plates. (London: J. and A. Churchill, 1921.) 7*s.* 6*d.* net.

DR. COLES gives a clear account of various small alterations in his microscopical outfit which have enabled him to obtain better results, and he describes concisely the methods and adjustments necessary in order to obtain the highest resolving power. He has had particularly in mind the needs of protozoologists who have often to search for a minute organism present in small numbers. For conducting such a search the author strongly advises the use of a dry lens, such as the 8-mm. apochromatic, which can be employed on covered or uncovered preparations and with ordinary transmitted light, or with dark-ground illumination. He gives details of his method, first published in 1914, for detecting the presence of spirochætes, in uncovered preparations, with this low magnification. His account will be helpful to many workers who may not have realised how much can be done with a good 8-mm. objective. Useful hints are also given on sub-stage condensers, dark-ground illumination, and photomicrography. The author directs attention to the great importance of applying a correction for the thickness of the cover glass by means of a correction-collar on the objective, or, better, by alteration in the tube length. He quotes a number of useful explanations, by Mr. E. M. Nelson, of the optics of the microscope. A short explanatory note on "numerical aperture" and its significance might have been added.

Stanford University Publications, University Series: Mathematics and Astronomy. Vol. 1, No. 1: *Primitive Groups.* Part 1. By Prof. W. A. Manning. Pp. 108. (California: Stanford University, 1921.) 1.25 dollars.

THE first eighty pages of this book are devoted to an introduction to the theory of finite groups somewhat on the lines followed by many similar treatises. A special feature is the early stage at which group-characteristics are discussed, and nearly half of the introductory portion of the book is given up to an investigation of their properties and applications. The author makes no very marked distinction between permutation-groups, substitution-groups, and abstract groups, but passes easily from one to the other, as suits his purpose. His style is pleasant, but the proofs are a trifle condensed, as if he had felt acutely his limitations of space. The book will be more useful to the reader who has some slight acquaintance with the subject than to the beginner.

The properties of primitive groups occupy the last third of the treatise, which is far more specialised and contains more original matter. These pages will appeal to the intending researcher rather than to the mathematician requiring a knowledge of general outlines.

Print and arrangement are quite attractive. There is a good contents list, but the absence of an index is regrettable. If the remaining Stanford University publications all come up to the standard of this first number, they will indeed fulfil a useful purpose. HAROLD HILTON.

Moby-Dick or the Whale. By H. Melville. With an introduction by Viola Meynell. (The World's Classics.) Pp. xii+675. (London: Humphrey Milford: Oxford University Press, 1920.) 2*s.* 6*d.* net.

THIS highly dramatic story, first published in 1851, though but little known to present-day readers, is a remarkable literary achievement, and deserving of attention on that score. In the course of its thrilling chapters is one entitled "Cetology," in which is given a whaler's descriptions of all the known species of Cetacea, their habits, distinctive features, and commercial value. The descriptions are embellished with many literary flourishes, but are nevertheless vivid and have a certain zoological value. "Moby-Dick" is a white sperm-whale that is madly pursued by one Ahab, who in the past has suffered loss by its jaws. More of the tale we must not tell: suffice it to say that "Midshipman Easy" and "The Cruise of the *Cachalot*" pale beside it.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Apparatus of Dr. Russ.

I HOPE Dr. Hartridge will pardon my suggestion that he is dismissing the possible effects of temperature too lightly.

In the Phil. Trans. Roy. Soc. of 1792, p. 86, Mr. Bennett described apparatus of great sensibility, in which a piece of dragon-fly wing or thistledown carried on a light arm suspended by a spider line in a closed case responded with amazing sensibility to the heat from a person at a distance in virtue of convection currents set up by the warmer side of the case. It is not surprising that suggestions of animal magnetism should have been made, *e.g.* that the right hand should act oppositely to the left, but the author of the paper ignored these, and was content with explanations based upon known laws of physics.

A little later (1798) Cavendish in his famous paper on the mean density of the earth showed how potent minute differences of temperature were to disturb even the 2-in. balls of lead that he suspended from the ends of his lever.

In 1862 Joule described in the Proc. Lit. and Phil. Soc. Manchester, p. 73, a convection thermometer in which a glass tube 2 ft. long and 4 in. in diameter was divided longitudinally into two portions by a diametrical partition extending to within about 1 in. of the top and bottom. "In the top space a bit of magnetised sewing-needle, furnished with a glass index, is suspended by a single filament of silk." The draught up on the warmer side and down on the cooler side caused the needle to be deflected, acting on the glass index as a wind-vane. This was found to be a superlatively delicate radiation thermometer.

In 1890, in conjunction with the late Dr. Watson and Mr. Briscoe, I showed to the Physical Society (*Phil. Mag.*, 1891, p. 59) an experiment which increased the delicacy of the Joule thermometer very greatly by replacing the straw and silk by a mirror and counterweight hung by a quartz fibre, but we found that by no system of screening, even in a cellar, could we maintain such quiet in the air as to allow the mirror to remain anywhere near the neutral position or to remain at rest. One side or the other was the hotter, and this was always changing. If we had never succeeded in obtaining a real state of rest the delicacy would have been useless. We, however, hit upon a plan which did keep the two sides strictly alike in temperature. We surrounded the tube by an exterior glass tube kept turning on its axis rapidly by clockwork all day. As the exterior glass was opaque to "dark heat" and no light was allowed to fall on the tube, the inner tube could not have one side hotter than the other, and then the mirror came to its neutral position and was very fairly steady there, so that heat developed electrically on one side of the partition in warming the air gave rise to deflections which could be measured with some certainty.

In all the delicate work that I have done with quartz-fibre suspensions the strictest attention to freedom from disturbance by air movement was essential to success. Only by such special care can air movements of so small an amount as 1 in. in a fortnight or so be avoided, and if not avoided a stable zero on which everything must depend is impossible.

In no ordinary large apparatus of the physical laboratory is the air ever quiet, and in the closed box of Dr. Russ is it safe to suppose that there are not convection currents abundantly able to cause deflection of anything suspended by a single silk fibre?

C. V. BOYS.

The Designation of the Radium Equivalent.

IN all problems that are primarily concerned with strictly radio-active phenomena the quantity λN, denoting the number of atoms transformed in a unit of time, plays a very important part. In such problems comparable amounts of different radio-elements are such as correspond to the same value of λN. There is need for a name to denote the amount of any radio-element, irrespective of family, that is thus comparable to one gram of radium. If, tentatively, we use the letter r to denote this desired name, then an r of any material may be defined as that amount of the material that will produce transformed atoms at the same rate as transformed atoms are produced by one gram of radium. The quantity r plays in radio-activity a part that is analogous to that played by the gram-molecule in physical chemistry, and the advantages to be secured by naming it are quite similar to those that were secured by the introduction of the term "gram-molecule."

As the curie is an r of radium emanation, the adoption of a new name to denote the quantity r will give two names for the same quantity of radium emanation. The majority of those with whom the subject has been discussed regarded this as undesirable. They consider it better to redefine the curie so as to cover the entire field.

I shall be glad if you will publish this letter so that a further expression of opinion may be obtained. A more detailed presentation of the subject will shortly appear in the Journal of the Washington Academy of Sciences.

N. ERNEST DORSEY.

Bureau of Standards, July 30.

Pisidium clessini in British Lochs.

DR. ANNANDALE (NATURE, August 18, p. 778) assumes from Mr. B. B. Woodward's letter that this species is a deep-water form, but this is not so. *P. clessini* is abundant in some of the Welsh and Kerry tarns, where Mr. Charles Oldham and I have collected it in from 1 to 4 ft. of water. It is a form which I have had under observation for some years past—indeed, since I first collected it on Brandon Mountain in Co. Kerry in 1910.

Not being able to identify it with any described species of Pisidium, I have several times been on the point of figuring it as new. At the last moment, however, I have always been checked by the fact that I was not satisfied that it was a good species. This view, I may say, is shared by my colleagues, Mr. Charles Oldham and Mr. R. A. Phillips. We are not satisfied that *P. clessini* is anything but a cold-water (depauperate) form of the widespread *P. casertanum*. This latter occurs abundantly also in many mountain tarns, but is always—in our experience—conspicuous by its absence in those in which *P. clessini* occurs.

Superficially, *P. clessini* is very distinct, and Dr. Odhner is satisfied that its anatomical characters render it necessary that we should regard it as a species; yet he has not been able to assure me that these characters are not the result of starvation acting over a prolonged period on a number of generations. For my own part I shall not be satisfied in its standing as a species until I can find it living in association

with *P. casertanum*. In Cwm Clyd on Y Garn, in North Wales, I have taken *P. casertanum* within a few yards of *P. clessini*, but the former was in a shallow swamp which warmed up in the summer, while the latter was living in the very cold water of Llyn Clyd. A. W. STELFOX.

National Museum, Dublin.

Scientific Publication.

THERE is at present much discussion of the difficulties of scientific publishing, and such discussion with resultant action is necessary, for there are few, if any, signs of reduction in printing costs, and the output of manuscript is steadily increasing. Societies issuing journals cannot meet their expenses unless the present high subscriptions are maintained, or in many cases increased, and most of us can with difficulty withstand the present drain upon our resources, and certainly cannot afford another penny in this direction. There would seem to be three alternatives before us. One is to ask each author to pay for or subsidise the publication of his own paper. This in many cases is financially impossible, and in any event introduces a whole series of new and very difficult problems, which renders it an extremely undesirable solution. The second is to reorganise our scientific societies and publishing boards with a lumping together of transactions, journals, annals, etc., and a consequent cheapening of direction and production. This is, to my way of thinking, the obvious solution, but few seem to agree thereon. The third method is to make a radical change in the format of our scientific journals, with or without an alteration in the existing structural relations of the learned societies. This is the substance of the present letter.

Perhaps there are two main reasons why people write scientific papers: first, that the authors really believe that their work will help forward the progress of science; and, secondly, that, having spent one or more years investigating a problem, they naturally wish to justify their time to themselves and their colleagues, to keep their names before the scientific public, and to give a basis for promotion in the scientific hierarchy. The memoirs are very stereotyped, being written in moderate detail with selected, and occasionally digested, original matter, and rounded off with a little summary; and so the very necessary, and more ignoble, aim is achieved. But is this time-honoured method of scientific publication really the best way to advance science? Moreover, in these stringent post-war days can we really afford, both financially and scientifically, to continue unaltered in our pre-war habits? Can we expect to publish our papers of pre-war length in pre-war style, or must we recognise that times have changed and modify our scientific ways and our journals accordingly?

What, after all, is the fate of a technical research paper in, let us say, botanical science? So many papers are published that it is a sheer impossibility to read more than a tithe. Moreover, the various aspects of botany are so specialised that the memoirs from one branch are not very intelligible to workers in other branches, or at the best do not arouse any great enthusiasm. In consequence, when a journal is published, many botanists just glance through the contents (who has not done this?), and if nothing catches their eye the journal is returned to the shelf; others read the summaries and are content; whilst a few, a very few, read carefully through the entire journal, or, more usually, through some particular memoir. Again, a morphologist reading, shall we say, a physiological paper is often lost in the data and formulæ, and longs for a clear-cut statement of what it is all about; and a physiologist reading the same memoir sighs sceptically over the abbreviated tables and graphs, and wishes to see more of the original figures and experimental details. The position is, in fact, that for the great majority of us all that is really necessary or useful is a very full summary or a *précis* of the paper—unless we happen to be one of the dozen or so investigators of like or cognate problems, when what we really need is a much more detailed presentation of the original matter. The present method, trying to please everybody, satisfies no one.

Now what I would say is this. Let us face reality, and let us quite frankly recognise—as sooner or later we shall be compelled to recognise—the financial limitations of our pockets and the space limitations of our periodicals. If we are to cater for the specialist, let us do it properly and write up our investigations in great detail with full original data, both negative and positive. Then very few researches can be published, for a journal could contain only one or two; and we should depend for our general literature, as of course we do now, on abstracting journals. If we are single-minded, and consider only the progress of knowledge, there is much to be said for this plan, for most of us admit that two-thirds of the scientific papers published are merely records of time spent, and have no permanent, and little (if any) temporary, value in the advancement of learning.

The alternative plan, and perhaps the more feasible, is to retain the scientific journals for the general scientific public and delete the long and very technical portions of the memoirs. The journals would then contain a number of very full summaries, the real essence of the studies, with the minimum of original data necessary for their comprehension. This would mean that the essential results of investigations could be produced much more rapidly, and this, with the volume of manuscript awaiting publication, would be advantageous; and, secondly, that the results would become much more widely known, being more readable. Further, in the majority of cases, owing to the elimination of expensive tables and plates (in any case most plates are, except in very special cases, a sheer anachronism and luxury in these days), the costs of production would be reduced by more than one-half, and this—there is no use blinking the fact—is for most of us a very material consideration indeed.

With regard to the full results of the investigations for specialist purposes, I would suggest that these be written up in the greatest detail, incorporating the essential working notes, so that anyone repeating the work could find in the memoir every required datum. These memoirs, together with the original drawings and photographs, type-slides, and specimens, would then be filed for reference in a kind of Somerset House for scientific records. This might be a central institution, as the British Museum, or preferably a decentralised scheme would be adopted, and botanical memoirs filed at Kew, zoological ones at the Natural History Museum, chemical ones at the Institute of Chemistry, and so forth. Very important papers much in demand might be mimeographed, or duplicated by photography or some other cheap process, and copies purchased at cost price by the principal research laboratories, or in special cases the originals could be sent to responsible investigators. These and many other elaborations could be adumbrated.

The above is the merest suggestion of what I cannot help thinking is a feasible scheme that would go

far towards solving many of our chief difficulties. It is perhaps somewhat revolutionary, but, whether we like it or not, even the scientific times move forward, and we can no longer maintain—most of us cannot afford to maintain—our pre-war usages. One would like opinions on this matter, for action of some kind will need to be taken in the not distant future.

WILLIAM B. BRIERLEY.

Rothamsted Experimental Station,
Harpenden, August 29.

Whispering-Gallery Phenomena at St. Paul's Cathedral.

THE very curious and interesting acoustical effects observed in the Whispering Gallery under the dome of St. Paul's Cathedral have, as is well known, been explained by the late Lord Rayleigh as due to the curvilinear propagation of sound, the waves which proceed from a source placed close to the wall of the gallery clinging to its surface and creeping tangentially along it. This view was developed mathematically by Lord Rayleigh ("Scientific Papers," vol. 5, p. 617), the theoretical conclusions arrived at being (*a*) that the sound-waves travel in a comparatively narrow belt skirting the wall, the thickness of this belt decreasing with the wave-length of the sound; (*b*) that in this belt the intensity is a maximum near the wall and decreases rapidly and continuously as we proceed radially away from it; and (*c*) that the intensity does not fluctuate markedly as we proceed circumferentially parallel to the wall.

We were much interested in the subject, and by the courtesy of the authorities of the cathedral have been enabled to carry out an extended series of observations in the gallery with the view of making a precise test of Lord Rayleigh's theory. Our experiments show conclusively that while the indication of theory as expressed in (*a*) is substantially accurate, neither of the conclusions (*b*) and (*c*) is in accordance with actual facts. Using a steady source of sound placed close to the wall at one point, we found that elsewhere the intensity of the sound showed pronounced oscillations in proceeding inwards radially from the wall, the ear of the observer passing several times through alternate zones of great intensity and of comparative silence. In the latter some of the overtones of the source could be heard clearly, while the fundamental was practically inaudible. These alternations of intensity could be demonstrated in the gallery, using a fairly high-pitched source and a sensitive flame as indicator. The distance between the successive zones of silence was about the same as the half-wave-length of the source. There were also distinct periodic fluctuations of intensity in proceeding circumferentially—that is, parallel to the wall. The latter were not equally distinct in all parts of the gallery, being most marked at the other end of the diameter containing the source.

The circumferential fluctuations of intensity might be interpreted as being, at least in part, due to the stationary interferences of waves which meet after passing in opposite directions round the gallery. But the radial fluctuations are less easily explained, and must be regarded as fundamental in any satisfactory theory of the Whispering Gallery. We find that effects similar to those we observed at St. Paul's may be demonstrated in the laboratory with any large circular reflecting surface, using a bird-call with a sensitive flame as sound-detector.

The experiments thus show that, while the explanation put forward by Lord Rayleigh is at least on the right lines, it is far from being a completely satisfactory theory of the Whispering Gallery. We propose at an early opportunity to go more fully elsewhere into the question of the revision necessary in the theory.

C. V. RAMAN.
G. A. SUTHERLAND.

22 Oxford Road, Putney, S.W.15, August 26.

Ceratium furca and Pedalion mirum.

IN describing the specific characteristics of *Ceratium furca*, one of the Peridiniæ or Dinoflagellates, Saville Kent in his "Manual of the Infusoria" gives the habitat as salt-water, and he appends a note to the effect that, "although usually regarded as entirely marine, M. Werneck has reported the occurrence of an apparently identical species in fresh-water in the vicinity of Salzburg."

It may be of interest to students of the Protozoa to state that on August 19 and 27 I discovered this species in two separate bodies of fresh-water in this district. It may be the case that other workers have found the form at other points in Great Britain, and that, by reason of my not having access to the scattered literature on Protozoa, I am only reporting an already well-established fact; but it will be most interesting to know whether *Ceratium furca* has been found elsewhere in this country, and I shall be glad to have the views of those who have given attention to this matter.

Kent gives the entire length of *C. furca* as 1/120th of an inch, say 212 microns. I find that very few of my specimens are so small as this, and I have measured several up to 256 microns, which is 21 per cent. larger than the recorded length.

The remarkable and interesting Rotifer, *Pedalion mirum*, discovered by Dr. Hudson in 1871 is described in Hudson and Gosse's classical work, "The Rotifera," as being very rare, and up to the date of the publication of that work, twelve years later, it had been recorded only from three places. Others have doubtless since been added, but Pedalion may probably still be regarded as a rare species. I have found it in both the waters in which *Ceratium furca* occurred, and in the first gathering on August 19 it was fairly numerous. A list of the known habitats of this Rotifer would be most interesting.

ALFRED E. HARRIS.

44 Partridge Road, Roath, Cardiff, August 29.

Illumination of Plankton.

IN avoiding compressed-air illness by the excellent method which we owe to Dr. J. S. Haldane, divers ascending from deep water often have to spend periods of half an hour or so in idleness suspended on a rope in mid-water 20–30 ft. below the surface. The blank tedium of such occasions can be relieved by watching the ebb and flow of plankton past the face-glass of the helmet and musing on the remarkable variation in its apparent quality and quantity from day to day.

As the diver looks upwards and inwards towards the black, shadowy keel of the salvage vessel he sees the individuals of the plankton standing out vividly by a sort of dark-ground illumination. Turning his head outwards and looking into unrelieved water space, again using a simile from microscopy, the field is overflooded with light, contrast is absent, and the teeming multitudes blend into granular haziness. In August, after our salvage ship has been moored for an hour or two in the open sea, mackerel find her out, and daily a compact shoal of them con-

gregates some 20–40 ft. below, remaining in position until she gets under way and quits the spot.

A diver hanging in the shoal has a clear space some 6 ft. wide around him; beyond this the water is crammed with mackerel, the outline of the shoal corresponding roughly with that of the ship above. One sees that the fish are feeding on plankton, not by steadily pumping the water through their gill-filters, but snatching gulps from different directions, turning their eyes about and making little jumps here and there. Evidently the depth they maintain, slightly different from day to day, is that at which their food is drifting; but what is the mysterious attraction that keeps roving fish fixed beneath a stationary ship for hours together?

A paper by Bullen in the Journal of the Marine Biological Association for June, 1912, produces evidence (from examination of stomach contents and aquarium observations) that mackerel when feeding on plankton exercise selective powers, picking out certain forms, such as Copepods, and rejecting others, presumably by visual means. After observing the shoals on many occasions while hanging suspended in their midst, I feel sure that it is the assistance given by the black background of the ship to visual selection that links the fish to her.

Most objects floating in the open seas, jellyfish, sharks, driftwood, or derelicts, when carefully approached, are found to be accompanied by fish satellites. The attractive force is not necessarily the same in every case, but where (as in the case of the mackerel under the salvage ship) the stomach contents turn out to be selected plankton it is probably a matter of illumination.

It is likely that each member of a shoal is benefited by the background afforded by the bodies of its immediate neighbours, and, if so, a factor in the shoaling habit comes to light. Going deeper, a use suggests itself for the lateral light-producing organs of some bathypelagic fishes which are so placed that they can scarcely assist the fishes' own vision.

G. C. C. DAMANT.

H.M. Salvage Vessel *Racer*, Lough Swilly.

Co-operative Indexing of Periodical Literature.

I AM much interested in the leading article in NATURE of June 9 entitled "Co-operative Indexing of Periodical Literature," because the H. W. Wilson Company is doing on a commercial basis what the publications you mention are doing on what you call a "co-operative basis." This leads to an inquiry as to when the publication of an index or abstract is "co-operative." Perhaps co-operation meant originally the donation of indexing work on the part of individuals or libraries. However, it appears that of the co-operative publications mentioned none of the editorial work is donated. The "Engineering Index" is now published by one of the great engineering societies, and its deficit paid by that society. The deficit of the "Index Medicus" is met by the Carnegie Institution of Washington. The deficit of the "Index to Legal Periodicals," published by the H. W. Wilson Company, is made good out of the treasury of the Association of Law Libraries, and the deficit of the "Agricultural Index" is made good out of the treasury of the H. W. Wilson Company. In the case of all these publications subscriptions are solicited, and the income is used to pay for editorial work and expenses so far as it will go, the deficits being met as stated. Is the publication of an index less "co-operative" if the deficit is met by an individual or a corporation than if it is met by an association or a foundation? In other words, should not a corporation engaged in an educational work be recognised as "co-operating" with men of science and scholars in the diffusion of knowledge?

Librarians say that indexes are more used in libraries than abstracts and digests. This, of course, does not imply that abstracts and digests are not useful to scientific and professional people, but since the chief support for abstracts, indexes, and digests comes from libraries, should not the advice of librarians be considered? A mere examination of the physical condition of various indexes and abstracts in libraries might be a fair indication of their comparative usefulness, and prove to be a revelation to those who are paying some of the deficits.

At one time the subject of agriculture was considered by the Committee on the International Catalogue of Scientific Literature, and it was expected that a volume covering this subject would some time be published. The publishing of our "Agricultural Index" gives opportunity to compare the value of a dictionary-catalogue published on the "cumulative plan" monthly, annually, and triennially with a classified catalogue published only (and tardily) as an annual. Would it not be interesting to make inquiries among those who use such reference tools most in order to determine what method is most efficient? If it should be found that indexing and cataloguing publications produced by private corporations actually serve a useful purpose, and perhaps relieve "co-operative" organisations of some share of the deficit, should not these publications receive, if not commendation, at least a nod of recognition?

I have wondered why men of science, when planning catalogues or classifications, do not consult those who make that work a profession. When people build houses it is generally thought best to consult an architect.

It may be worth while to note that of the four examples of indexes that you mention, three are now compiled on the alphabetic or dictionary plan. The "Engineering Index," published since 1884, changed from the classified to the dictionary form on the annuals with the year 1919. The "Index Medicus" has just recently changed from the classified to the alphabetic form. We believe the changes were made at the request of librarians who have, through their experience, found the dictionary plan the more serviceable.

It is to be hoped that in the conference proposed by NATURE, to which representatives of all branches of knowledge are to be invited, librarians and all those who make printed indexes will be included.

H. W. WILSON,
President.

The H. W. Wilson Company, Publishers of Indexes and Reference Works, 958–964 University Avenue, New York City, August 6.

A CO-OPERATIVE index is one published by, or on behalf of, a professional body with the view of securing an adequate standard of efficiency. These indexes are generally based, in part at any rate, upon voluntary labour. Mr. Wilson is in error in supposing that the main support for abstracts and digests comes from the libraries. It is derived from the subscriptions of members of the professional bodies. Librarians are not qualified to advise on the matter.

Indexing suffers chiefly from the lack of co-ordination and the insufficient supply of trained workers. It is to secure a proper co-ordination of effort that a conference has been proposed in these columns. The conference should undoubtedly include representatives of the libraries and of the commercial indexes.

THE WRITER OF THE ARTICLE.

The British Association at Edinburgh.

THE prospects of a first-rate meeting in Edinburgh are now assured. The journal, which extends to more than forty pages, shows that all the sections will have a full programme—in fact, the difficulty in several cases has been to fit the communications into the time available. The number of members already enrolled indicates that the total entry will exceed 2000, so that from a numerical, as well as from other points of view, the Edinburgh meeting is certain of success. The proof copy of the list of members shows that British science is to be strongly represented at the meeting. In the list are the names of many well-known men of science, including about one hundred fellows of the Royal Society. Three past-presidents of the Association will attend the meeting—Sir James Dewar, Sir Oliver Lodge, and Sir Edward Sharpey Schafer—in addition to Prof. Herdman, who resigns the office of president to Sir Edward Thorpe.

A goodly number of overseas and foreign men of science have signified their intention of being present at the meeting. Physics, mathematics, and chemistry are represented by Prof. Svante Arrhenius (Stockholm), Prof. H. E. Fierz (Zürich), Prof. F. M. Jaeger and Prof. Kapteyn (Gröningen), Dr. Irving Langmuir (New York), Prof. J. C. McLennan (Toronto), Dr. Hans Petterssen (Gothenberg), Prof. Volterra (Rome), and Prof. R. W. Wood (Johns Hopkins University). Geology and zoology have also a goodly representation of men of science from overseas. In the former section are Prof. Collet (Geneva), Prof. R. A. Daly (Harvard), Baron de Geer (Stockholm), and Prof. Kolderup (Bergen), while in the section of zoology are Prof. J. F. van Bemmelen and Prof. J. W. van Wijhe (Gröningen), Prof. Hérouard (Paris), and Prof. Vernon Kellogg (Washington). Other foreign representatives are Dr. Krogh (Copenhagen), in the section of physiology, Dr. Langfeld (Harvard), in the section of psychology, and Dr. J. P. Lotsy (Holland), in the section of botany. Most of these are to take part in the proceedings of the sections, either by presenting some communication on their recent work, or by joining in the discussions which have been arranged.

There will be a daily weather report for Edinburgh. The Meteorological Office, Air Ministry, has arranged that during the week over which the meetings of the British Association extend—September 7–14—a demonstration will be given daily of the methods employed in preparing the British daily weather map and in forecasting the weather in different districts of the country during the ensuing twenty-four hours. For this purpose a temporary branch of the Meteorological Office, Edinburgh, is being opened in the natural philosophy department of the university, in which building the meetings of Section A (Mathematics and Physics) are being held. This temporary office is being supplied with wireless apparatus capable of receiving all the different European synoptic messages. In addition, arrangements are being made for the receipt of weather messages from various centres by telegraph and telephone, including messages from ships in the Atlantic, and some of the information which is ordinarily collected by the Air Ministry for the purposes of aviation.

Most of the meteorological data thus collected will be represented on a large blackboard map which has been erected in the entrance hall of the natural philosophy department, where it can be seen by those attending the meetings. Some information chiefly referring to local or Scottish weather conditions will also be shown. The area over which the map extends is from Spitsbergen, in the north, to Africa, in the south, and from Warsaw to the Azores, and it is expected that the representation on it of the morning's weather throughout this area will be complete by 10 a.m.

A local daily weather report, embodying the more important data on the map, will be issued by 11 a.m., and a limited number of copies will be ready for issue soon after that hour. The report will include a "general inference" from the ascertained pressure distribution, as well as a special forecast for the Edinburgh district.

The demonstration will show what information can be obtained by the use of a suitable wireless receiving instrument, and how that information may be utilised; and it will illustrate the methods by which Scotland generally, and Edinburgh in particular, could be served in the matter of prompt and accurate information with regard to the weather of the day and its probable changes in the ensuing twenty-four hours.

J. H. ASHWORTH.

Some Aspects and Problems of Post-war Science, Pure and Applied.*

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President.

THE British Association for the Advancement of Science owes its origin, and, in great measure, its specific aims and functions, to the public spirit and zeal for the interests of science of Scotsmen. Its virtual founder was Sir David Brewster; its scope and character were defined by Principal Forbes. In constitution it differed from the migratory scientific associations existing on the Continent, which mainly served to promote the social intercourse of their members by annual

* Presidential address delivered at the Edinburgh meeting of the British Association on September 7.

gatherings, in that it was to be a permanent organisation, with a settled establishment and headquarters, which should have not merely its yearly reunions, but which, "by methods and by influence peculiarly its own, should continue to operate during the intervals of these public assemblies, and should aspire to give an impulse to every part of the scientific system; to mature scientific enterprise; and to direct the labours requisite for discovery."

Although, for reasons of policy, it was decided that its first meeting of September 27, 1831, should be held at York, as the most central city for the three kingdoms, and its second and third meetings at the ancient Universities of Oxford and Cambridge respectively, it was inevitable that the Association should seize the earliest opportunity to visit the Metropolis of Scotland, where, as an historical fact, it may be said to have had its origin.

The meeting in this city of September 8, 1834, was noteworthy for many reasons. It afforded the first direct proof that the Association was fulfilling its purpose. This was shown by the popular appreciation which attended its activities, by the range and character of its reports on the state and progress of science, by the interest and value of its sectional proceedings, and by the mode in which its funds were employed. In felicitous terms the president of the preceding year, the Rev. Prof. Sedgwick, congratulated the gathering "on the increased strength in which they had assembled, in a place endeared to the feelings of every lover of science by so many delightful and elevating recollections, especially by the recollection of the great men whom it had fostered, or to whom it had given birth." In a few brief sentences Prof. Sedgwick indicated the great power which this Association is able to apply towards the advancement of science by combination and united action, and he supported his argument by pointing to the results which it had already achieved during the three short years of its existence. Prof. Sedgwick's words are no less true to-day. His contention that one of the most important functions of this philosophical union is to further what he termed the "commerce of ideas" by joint discussions on subjects of kindred interest, has been endorsed by the recent action of the Council in bringing the various sections into still closer touch with each other with a view to the discussion of common problems of general interest. This slight reorganisation of the work of the sections, which is in entire accord with the spirit and aims of the Association, as defined by its progenitors and formulated in its constitution, will take effect during the present meeting. Strictly speaking, such joint sectional discussions are not unknown in our history, and their utility and influence have been freely recognised. But hitherto the occasions have been more or less informal. They are now, it is hoped, to be part of the regular official procedure of the meetings, to which it is anticipated they will afford additional interest and value.

Another noteworthy change in our procedure is the introduction of discussions on the addresses of the presidents of sections. Hitherto these addresses have been formally read and never discussed. To the extent that they have been brief chronicles of the progress of the special departments of science with which the section is concerned they have given but little opportunity for discussion. With the greatly increased facilities which now exist for every worker to keep himself informed of the development of the branch of knowledge in which he is more particularly interested, such *résumés* have in great measure lost their true purpose, and there has, consequently, been a growing tendency of late years for such presidential addresses to deal with contemporary topics of general interest and of fundamental importance, affording ample opportunity for a free exchange of opinion. The experiment will certainly conduce to the interest of the proceedings of the sections, and will contribute to the permanent value of their work. We see in these several changes the development of ideas connected with the working of the Association which may be said to have had their birth at its first meeting in Edinburgh, eighty-seven years ago.

Sixteen years later—that is, on July 21, 1850—Edinburgh again extended her hospitality to the British Association, which then honoured itself by electing the learned principal of the united colleges of St. Salvator and St. Leonard, St. Andrews, to the presidential chair—at once a tribute to Sir David Brewster's eminence as a natural philosopher, and a grateful recognition of his services to this body in suggesting and promoting its formation.

On the occasion of his inaugural address, after a brief account of recent progress in science, made with the lucidity of expression which characterised all the literary efforts of the learned biographer of Newton and versatile editor of the *Edinburgh Encyclopaedia*, the *Edinburgh Magazine*, and the *Edinburgh Journal of Science*, the president dwelt upon the beneficent influence of the Association in securing a more general attention to the objects of science, and in effecting a removal of disadvantages of a public kind that impeded its progress. It was due largely to the action of the Association, assisted by the writings and personal exertions of its members, that the Government was induced to extend a direct national encouragement to science and to aid in its organisation.

Brewster had a lofty ideal of the place of science in the intellectual life of a community, and of the just position of the man of science in the social scale. In well-weighed words, the outcome of matured experience and of an intimate knowledge of the working of European institutions created for the advancement of science and the diffusion of knowledge, he pleaded for the establishment of a national institution in Britain possessing a class

of resident members who should devote themselves wholly to science—with a place and station in society the most respectable and independent—"free alike," as Playfair put it, "from the embarrassments of poverty or the temptations of wealth." Such men, "ordained by the State to the undivided functions of science," would, he contended, do more and better work than those who snatch an hour or two from their daily toil or nightly rest.

This ideal of "combining what is insulated, and uniting in one great institution the living talent which is in active but undirected and unbefriended exercise around us," was not attained during Brewster's time, nor, notwithstanding the reiteration of incontrovertible argument during the past seventy years, has it been reached in our own.

I have been led to dwell on Sir David Brewster's association with this question of the relations of the State towards research for several reasons. Although he was not the first to raise it—for Davy more than a century ago made it the theme of presidential addresses, and brought his social influence to bear in the attempt to enlist the practical sympathy of the Government—no one more consistently urged its national importance or supported his case with a more powerful advocacy than the principal of the University of Edinburgh. It is only seemly, therefore, that on this particular occasion, and in this city of his adoption, where he spent so much of his intellectual energy, I should specially allude to it. Moreover, we can never forget what this Association owes to his large and fruitful mind. Every man is a debtor to his profession, from which he gains countenance and profit. That Brewster was an ornament to his is acknowledged by every lover of learning. That he endeavoured to be a help to it was gratefully recognised during his lifetime. After his death it was said of him that the improved position of men of science in our time is chiefly due to his exertions and his example.

I am naturally led to connect the meeting of 1850 with a still more memorable gathering of this Association in this city. In August, 1871—just more than half a century ago—the British Association again assembled in Edinburgh under the presidency of Lord Kelvin—then Sir William Thomson. It was an historic occasion by reason of the address which inaugurated its proceedings. Lord Kelvin, with characteristic force and insistence, still further elaborated the theme which had been so signal a feature of Sir David Brewster's address twenty-one years previously: "Whether we look to the honour of England," he said, "as a nation which ought always to be the foremost in promoting physical science, or to those vast economical advantages which must accrue from such establishments, we cannot but feel that experimental research ought to be made with us an object of national concern, and not left, as hitherto, exclusively to the private enterprise of self-sacrificing amateurs, and the necessarily inconsecutive action of our present Governmental Departments and of casual committees."

Lord Kelvin, as might have been anticipated, pleaded more especially for the institution of physical observatories and laboratories for experimental research, to be conducted by qualified persons, whose duties should be not teaching, but experimenting. Such institutions as then existed, he pointed out, afforded only a very partial and inadequate solution of a national need. They were, for the most part, "absolutely destitute of means, material, or *personnel* for advancing science, except at the expense of volunteers, or of securing that volunteers should be found to continue such little work as could then be carried on."

There were, however, even then, signs that the bread cast upon the waters was slowly returning after many days. The establishment of the Cavendish Laboratory at Cambridge, by the munificence of its then chancellor, was a notable achievement. Whilst in its constitution as part of a university discipline it did not wholly realise the ideal of the two presidents, under its successive directors, Prof. Clerk Maxwell, the late Lord Rayleigh, and Sir J. J. Thomson, it has exerted a profound influence upon the development of experimental physics, and has inspired the foundation of many similar educational institutions in this country. Experimental physics has thus received an enormous impetus during the last fifty years, and although in matters of science there is but little folding of the hands to sleep, "the divine discontent" of its followers has little cause for disquietude as regards the position of physics in this country.

In the establishment of the National Physical Laboratory we have an approach to the ideal which my predecessors had so earnestly advocated. Other presidents, among whom I would specially name the late Sir Douglas Galton, have contributed to this consummation. The result is a remarkable testimony to the value of organised and continuous effort on the part of the British Association in forming public opinion and in influencing Departmental action. It would, however, be ungrateful not to recall the action of the late Lord Salisbury—himself a follower of science and in full sympathy with its objects—in taking the first practical steps towards the creation of this magnificent national institution. I may be allowed, perhaps, to refer to this matter, as I have personal knowledge of the circumstances, being one of the few survivors of the Committee which Lord Salisbury caused to be formed, under the chairmanship of the late Lord Rayleigh, to inquire and report upon the expediency of establishing an institution in Great Britain upon the model of certain State-aided institutions already existing on the Continent, for the determination of physical constants of importance in the arts, for investigations in physical problems bearing upon industry, for the standardisation and verification

of physical instruments, and for the general purposes of metrology. I do not profess to give the exact terms of the reference to the Committee, but in substance these were recognised to be the general aims of the contemplated institute. The evidence we received from many men of science, from Departmental officers, and from representatives of engineering and other industrial establishments was absolutely unanimous as to the great public utility of the projected laboratory. It need scarcely be said that the opportunity called forth all the energy and power of advocacy of Lord Kelvin, and I well remember with what strength of conviction he impressed his views upon the Committee. That the National Physical Laboratory has, under the ability, organising power, and business capacity of its first director, Sir Richard Glazebrook, abundantly justified its creation is recognised on all hands. Its services during the four years of war alone are sufficient proof of its national value. It has grown to be a large and rapidly increasing establishment, occupying itself with an extraordinary range of subjects, with a numerous and well-qualified staff, engaged in determinative and research work on practically every branch of pure and applied physics. The range of its activities has been further increased by the establishment since the war of co-ordinating research boards for physics, chemistry, engineering, and radio-research. Government Departments have learned to appreciate its services. The photometry division, for example, has been busy on experiments on navigation lamps for the Board of Trade, on miners' lamps for the Home Office, and on motor-car head-lamps for the Ministry of Transport, and on the lighting of the National Gallery and the Houses of Parliament. Important work has been done on the forms of ships, on the steering and manœuvring of ships, on the effect of waves on ship resistance, on the interaction between passing ships, on seaplane floats, and on the hulls of flying-boats.

It is also actively engaged in the study of problems connected with aviation, and has a well-ordered department for aerodynamical research.

It can already point to a long and valuable series of published researches, which are acknowledged to be among the most important contributions to pure and applied physics which this country has made during recent years.

I may be pardoned, I hope, for another personal reference if I recall that it was at the Edinburgh meeting, under Lord Kelvin's presidency, fifty years ago, that I first became a member of this Association, and had the honour of serving it as one of the secretaries of its chemical section. Fifty years is a considerable span in the life of an individual, but it is a relatively short period in the history of science. Nevertheless, those fifty years are richer in scientific achievement and in the importance and magnitude of the utilitarian applications of practically every branch of science than any preceding similar interval. The most cursory comparison of the state of science, as revealed in his comprehensive address, with the present condition of those departments on which he chiefly dwelt, will suffice to show that the development has been such that even Lord Kelvin's penetrative genius, vivid imagination, and sanguine temperament could hardly have anticipated. No previous half-century in the history of science has witnessed such momentous and far-reaching achievements. In pure chemistry it has seen the discovery of argon by Rayleigh, of radium by Mme. Curie, of helium as a terrestrial element by Ramsay, of neon, xenon, and krypton by Ramsay and Travers, the production of helium from radium by Ramsay and Soddy, and the isolation of fluorine by Moissan. These are undoubtedly great discoveries, but their value is enormously enhanced by the theoretical and practical consequences which flow from them.

In applied chemistry it has witnessed the general application of the Gilchrist-Thomas process of iron-purification, the production of calcium cyanamide by the process of Frank and Caro, Sabatier's process of hydrogenation, a widespread application of liquefied gases, and Haber's work on ammonia synthesis—all manufacturing processes which have practically revolutionised the industries with which they are concerned.

In pure physics it has seen the rise of the electron theory, by Lorentz; Hertz's discovery of electro-magnetic waves; the investigation of cathode rays by Lenard, and the elucidation of crystal structure by Bragg.

It has seen, moreover, the invention of the telephone, the establishment of incandescent lighting, the electric transmission of force, the invention of the cinematograph, of wireless telegraphy, the application of the Röntgen rays, and the photographic reproduction of colour.

In physical chemistry it has witnessed the creation of stereochemistry by Van t'Hoff and Le Bel, Gibbs's work on the phase rule, Van t'Hoff's theory of solutions, Arrhenius's theory of ionic dissociation, and Nernst's theory of the galvanic cell.

Such a list is far from complete, and might be greatly extended; but it will at least serve to indicate the measure of progress which the world owes to the development and application during the last fifty years of the two sciences—physics and chemistry—to which Lord Kelvin specially referred.

The more rapid dissemination of information concerning the results of recent or contemporary investigation, which Lord Kelvin so strongly urged as "an object to which the powerful action of the British Association would be thoroughly appropriate," has been happily accomplished. The timely aid of the Association in contributing to the initial expense of preparing and publishing monthly abstracts of foreign chemical literature by the Chemical Society is gratefully remembered by British chemists. The example has been followed by the greater number of our scientific and technical societies, and the results of contemporary inquiry in every important branch of pure and

applied science are now quickly brought to the knowledge of all interested workers. In fact, as regards the particular branch of science with which I am more directly concerned, the arrangements for the preparation and dissemination of abstracts of contemporary foreign chemical literature are proving to be a veritable embarrassment of riches, and there is much need for co-operation among the various distributing societies. This need is especially urgent at the present time owing to the greatly increased cost of paper, printing, binding, and indeed of every item connected with publication, which expense, of course, ultimately falls upon the various societies and their members. The problem, which has already received some attention from those entrusted with the management of the societies referred to, is not without its difficulties, but these are not insoluble. There is little doubt that a resolute and unanimous effort to find a solution would meet with success.

The present high cost of book production, which in the case of specialised books is about three times what it was in 1914, is exercising a most prejudicial effect upon the spread of scientific knowledge. Books on science are not generally among the "best sellers." They appeal to a comparatively limited and not particularly wealthy public, largely composed of the professional classes who have suffered in no small measure from the economic effects of the war The present high price of this class of literature is to the public detriment. Eventually it is no less to the detriment of the printing and publishing trades. Publishers are well aware of this fact, and attempts are being made by discussions between employers and the executives of the Typographical Association and other societies of compositors to reach an equitable solution, and it is greatly to be hoped that it will be speedily found.

All thinking men are agreed that science is at the basis of national progress. Science can develop only by research. Research is the mother of discovery, and discovery of invention. The industrial position of a nation, its manufactures and commerce, and ultimately its wealth, depend upon invention. Its welfare and stability largely rest upon the equitable distribution of its wealth. All this seems so obvious, and has been so frequently and so convincingly stated, that it is superfluous to dwell upon it in a scientific gathering to-day.

A late distinguished Admiral, you may remember, insisted on the value of reiteration. On this particular question it was never more needed than now. The crisis through which we have recently passed requires it in the interests of national welfare. Of all post-war problems to engage our serious attention, none is more important in regard to our position and continued existence than the nation's attitude towards science and scientific research, and there is no more opportune time than the present in which to seek to enforce the teaching of one of the most pregnant lessons of our late experience.

It is, unfortunately, only too true that the industrial world has in the past underrated the value of research. One indication that the nation is at length aroused to its importance is to be seen in the establishment of the Department of Scientific and Industrial Research, with its many subordinate associations. The outbreak of the Great War, and much in its subsequent history, revealed, as we all know, many national shortcomings, due to our indifference to, and actual neglect of, many things which are at the root of our prosperity and security. During the war, and at its close, various attempts, more or less unconnected, were made to find a remedy. Of the several committees and boards which were set up, those which still exist have now been co-ordinated and brought under the control of a central organisation—the Department of Scientific and Industrial Research. Research has now become a national and State-aided object. For the first time in our history its pursuit with us has been organised by Government action. As thus organised it seeks to fulfil the aspirations to which I have referred, whilst meeting many of the objections which have been urged against the endowment of research. It must be recognised that modern ideas of democracy are adverse to the creation of places to which definite work is not assigned and from which definite results do not emanate. This objection, which strikes at the root of the establishment of such an institution as Sir David Brewster contemplated, is, to a large extent, obviated by the scheme of the Department of Scientific and Industrial Research. It does not prescribe or fetter research, but, whilst aiding by personal payments the individual worker, leaves him free to pursue his inquiry as he thinks best. Grants are made, on the recommendation of an Advisory Council of experts, to research workers in educational institutions and elsewhere, in order to promote research of high character on fundamental problems of pure science or in suitable cases on problems of applied science. Of the boards and committees and similar organisations established prior to or during the war, or subsequent to it, with one or two exceptions, all are now directly under the Department. They deal with a wide range of subjects, such as the Building Research Board, established early in 1920 to organise and supervise investigations on building materials and construction, to study structural failures, and to fix standards for structural materials. The Food Investigation Board deals with the preservation by cold of food, and with the engineering problems of cold storage, with the chemistry of putrefaction, and the agents which induce it, with the bionomics of moulds, and the chemistry of edible oils and fats. The Fuel Research Board is concerned with the immediate importance of fuel economy and with investigations of the questions of oil-fuel for the Navy and Mercantile Marine, the survey of the national coal resources, domestic heating, air pollution, pulverised fuel, utilisation of peat, the search for possible substitutes for natural fuel oil, and for practicable sources of power alcohol.

The Geological Survey Board has taken over the Geological Survey of Great Britain and the control of the Museum of Practical Geology. The maintenance of the National Physical Laboratory, originally controlled by a general board and an executive committee appointed by the president and council of the Royal Society, is now transferred to the Department of Scientific and Industrial Research. A Mines Research Committee and a Mine Rescue Apparatus Committee are attached to the Department. The former is concerned with such questions as the determination of the geothermic gradient, the influence of temperature of intake and return air on strata, the effect of seasonal changes on strata temperature of intakes, the cooling effect due to the evolution of fire-damp, heat production from the oxidation of timber, etc. The Department is also directing inquiries on the preservation and restoration of antique objects deposited in the British Museum. It is concerned with the gauging of rivers and tidal currents, with special reference to a hydrographical survey of Great Britain in relation to the national resources of water-power. In accordance with the Government policy, four co-ordinating boards have been established to organise scientific work in connection with the fighting forces, so as to avoid unnecessary overlapping and to provide a single direction and financial control. The four boards deal, respectively, with chemical and physical problems, problems of radio-research, and engineering. These boards have attached to them various committees dealing with special inquiries, some of which will be carried out at the National Physical Laboratory. The Government have also authorised the establishment of a Forest Products Research Board.

The Department is further empowered to assist learned or scientific societies and institutions in carrying out investigations. Some of these were initiated prior to the war, and were likely to be abandoned owing to lack of funds. Whenever the investigation has a direct bearing upon a particular industry that had not hitherto been able to establish a research association, it has been a condition of a grant that the institution directing the research should obtain contributions towards the cost on a *l.* for *l.* basis, either directly through its corporate funds, or by special subscriptions from interested firms. On the formation of the appropriate association the research is, under suitable safeguards, transferred to it for continuance. The formation of a number of research associations has thus been stimulated, dealing, for example, with scientific instruments, non-ferrous metals, glass, silk, refractories, electrical and allied industries, pottery, etc.

Grants are made to research associations formed voluntarily by manufacturers for the purposes of research, from a fund of a million sterling, placed at the disposal of the Research Department for this purpose. Such associations, to be eligible for the grant, must submit articles of association for the approval of the Department and the Board of Trade. If these are approved, licences are issued by the Board of Trade recognising the associations as limited liability companies working without profits. Subscriptions paid to an association by contributing firms are recognised by the Board of Inland Revenue as business costs of the firms, and are not subject to income or excess profits taxes. The income of the association is similarly free of income tax. Grants are ordinarily made to these associations on the basis of 1*l.* for every 1*l.* raised by the association between limits depending upon the particular industry concerned. In the case of two research associations grants are made at a higher rate than *l.* for *l.*, as these industries are regarded as having a special claim to State assistance on account of their "pivotal" character. The results of research are the sole property of the association making them, subject to certain rights of veto possessed by the Department for the purposes of ensuring that they are not communicated to foreign countries, except with the consent of the Department, and that they may be made available to other interested industries and to the Government itself on suitable terms.

These arrangements have been found to be generally satisfactory, and at the present time twenty-four of such research associations have been formed to whom licences have been issued by the Board of Trade. Others are in process of formation, and may be expected to be at work at an early date. These research associations are concerned with nearly all our leading industries. The official addresses of most of them are in London; others have their headquarters in Manchester, Leeds, Sheffield, Birmingham, Northampton, Coventry, Glasgow, and Belfast.

The Department has further established a Records Bureau, which is responsible for receiving, abstracting, filing and collating communications from research workers, boards, institutions, or associations related to, or supervised by, the Department. This information is regarded as confidential, and will not be communicated except in writing, and after consultation with the research worker or organisation from which it has been received. Also such non-confidential information as comes into the possession of the Department which is of evident or probable value to those working in touch with the Department is collected and filed in the bureau and made generally available.

It is also a function of the bureau to effect economy in preventing repetition and overlapping of investigations and in ensuring that the fullest possible use is made of the results of research. Thus the programmes of research associations are compared in order to ensure that researches are not unwittingly duplicated by different research associations. Sometimes two or more research associations may be interested in one problem from different points of view, and when this occurs it may be possible for the bureau to arrange a concerted attack upon the common

problem, each research association undertaking that phase of the work in which it is specially interested and sharing in the general results.

As researches carried out under the Department frequently produce results for which it is possible to take out patents, careful consideration has been given to the problems of policy arising on this subject, and other Government Departments also interested have been freely consulted. As the result, an Inter-Departmental Committee has been established with the following terms of reference:—

(1) To consider the methods of dealing with inventions made by workers aided or maintained from public funds, whether such workers be engaged (*a*) as research workers, or (*b*) in some other technical capacity, so as to give a fair reward to the inventor and thus encourage further effort, to secure the utilisation in industry of suitable inventions and to protect the national interest; and

(2) To outline a course of procedure in respect of inventions arising out of State-aided or supported work which shall further these aims and be suitable for adoption by all Government Departments concerned.

About forty patents have been taken out by the Department jointly with the inventors and other interested bodies, but of these nine have afterwards been abandoned. At least five patents have been developed to such a stage as to be ready for immediate industrial application.

It will be obvious from this short summary of the activities of the Department of Scientific and Industrial Research, based upon information kindly supplied to me by Sir Francis Ogilvie, that this great scheme of State-aided research has been conceived and is administered on broad and liberal lines. A considerable number of valuable reports from its various boards and committees have already been published, and others are in the press, but it is, of course, much too soon to appreciate the full effects of their operations; but it can scarcely be doubted that they are bound to exercise a profound influence upon industries which ultimately depend upon discovery and invention. The establishment of the Department marks an epoch in our history. No such comprehensive organisation for the application of science to national needs has ever been created by any other State. We may say we owe it directly to the Great War. Even from the evil of that great catastrophe there is some soul of goodness would we observingly distil it out.

I turn now to a question of scientific interest which is attracting general attention at the present time. It is directly connected with Lord Kelvin's address fifty years ago.

The molecular theory of matter—a theory which in its crudest form has descended to us from the earliest times, and which has been elaborated by various speculative thinkers through the intervening ages, scarcely rested upon an experimental basis until within the memory of men still living. When Lord Kelvin spoke in 1871, the best-established development of the molecular hypothesis was exhibited in the kinetic theory of gases as worked out by Joule, Clausius, and Clerk Maxwell. As he then said, no such comprehensive molecular theory had ever been even imagined before the nineteenth century; but, with the eye of faith, he clearly perceived that, definite and complete in its area as it was, it was "but a well-drawn part of a great chart, in which all physical science will be represented with every property of matter shown in dynamical relation to the whole. The prospect we now have of an early completion of this chart is based on the assumption of atoms; but there can be no permanent satisfaction to the mind in explaining heat, light, elasticity, diffusion, electricity and magnetism, in gases, liquids, and solids, and describing precisely the relations of these different states of matter to one another by statistics of great numbers of atoms when the properties of the atom itself are simply assumed. When the theory, of which we have the first instalment in Clausius's and Maxwell's work, is complete, we are but brought face to face with a superlatively grand question: What is the inner mechanism of the atom?"

If the properties and affections of matter are dependent upon the inner mechanism of the atom, an atomic theory, to be valid, must comprehend and explain them all. There cannot be one kind of atom for the physicist and another for the chemist. The nature of chemical affinity and of valency, the modes of their action, the difference in characteristics of the chemical elements, even their number, internal constitution, periodic position, and possible isotopic rearrangements must be accounted for and explained by it. Fifty years ago chemists, for the most part, rested in the comfortable belief of the existence of atoms in the restricted sense in which Dalton, as a legacy from Newton, had imagined them. Lord Kelvin, unlike the chemists, had never been in the habit of "evading questions as to the hardness or indivisibility of atoms by virtually assuming them to be infinitely small and infinitely numerous." Nor, on the other hand, did he realise, with Boscovich, the atom "as a mystic point endowed with inertia and the attribute of attracting or repelling other such centres." Science advances not so much by fundamental alterations in its beliefs as by additions to them. Dalton would equally have regarded the atom "as a piece of matter of measurable dimensions, with shape, motion, and laws of action, intelligible subjects of scientific investigation."

In spite of the fact that the atomic theory, as formulated by Dalton, has been generally accepted for nearly a century, it is only within the last few years that physicists have arrived at a conception of the structure of the atom sufficiently precise to be of service to chemists in connection with the relation between the properties of elements of different kinds, and in throwing light on the mechanism of chemical combination.

This further investigation of the "superlatively

grand question—the inner mechanism of the atom"—has profoundly modified the basic conceptions of chemistry. It has led to a great extension of our views concerning the real nature of the chemical elements. The discovery of the electron, the production of helium in the radioactive disintegration of atoms, the recognition of the existence of isotopes, the possibility that all elementary atoms are composed either of helium atoms or of atoms of hydrogen and helium, and that these atoms, in their turn, are built up of two constituents, one of which is the electron, a particle of negative electricity the mass of which is only 1/1800 of that of an atom of hydrogen, and the other a particle of positive electricity the mass of which is practically identical with that of the same atom—the outcome, in short, of the collective work of Soddy, Rutherford, J. J. Thomson, Collie, Moseley, and others—are pregnant facts which have completely altered the fundamental aspects of the science. Chemical philosophy has, in fact, now definitely entered on a new phase.

Looking back over the past, some indications of the coming change might have been perceived wholly unconnected, of course, with the recent experimental work which has served to ratify it. In a short paper entitled, " Speculative Ideas respecting the Constitution of Matter," originally published in 1863, Graham conceived that the various kinds of matter, now recognised as different elementary substances, may possess one and the same ultimate or atomic molecule existing in different conditions of movement. This idea, in its essence, may be said to be as old as the time of Leucippus. To Graham as to Leucippus, " the action of the atom as one substance taking various forms by combinations unlimited, was enough to account for all the phenomena of the world. By separation and union with constant motion all things could be done." But Graham developed the conception by independent thought, and in the light of experimentally ascertained knowledge which the world owes to his labours. He might have been cognisant of the speculations of the Greeks, but there is no evidence that he was knowingly influenced by them. In his paper, Graham uses the terms " atom " and " molecule," if not exactly in the same sense that modern teaching demands, yet in a sense very different from that hitherto required by the limitations of contemporary chemical doctrine. He conceives of a lower order of atoms than the chemical atom of Dalton, and founds on his conception an explanation of chemical combination based upon a fixed combining measure, which he terms the *metron*, its relative weight being one for hydrogen, sixteen for oxygen, and so on with the other so-called " elements." Graham, in fact, like Davy before him, never committed himself to a belief in the indivisibility of the Daltonian atom. The original atom may, he thought, be far down.

The idea of a primordial ylé, or of the essential unity of matter, has persisted throughout the ages, and, in spite of much experimental work, some of it of the highest order, which was thought to have demolished it, it has survived, revivified and supported by analogies and arguments drawn from every field of natural inquiry. This idea, of course, was at the basis of the hypothesis of Prout, which, even as modified by Dumas, was held to be refuted by the monumental work of Stas. But, as pointed out by Marignac and Dumas, anyone who will impartially look at the facts can scarcely escape the feeling that there must be some reason for the frequent recurrence of atomic weights differing by so little from the numbers required by the law which the work of Stas was supposed to disprove. The more exact study within recent years of the methods of determining atomic weights and the great improvement in experimental appliances and technique, combined with a more rigorous standard of accuracy demanded by a general recognition of the far-reaching importance of an exact knowledge of these physical constants, have resulted in intensifying the belief that some natural law must be at the basis of the fact that so many of the most carefully determined atomic weights on the oxygen standard are whole numbers. Nevertheless, there were well-authenticated exceptions which seemed to invalidate its universality. The proved fact that a so-called element may be a mixture of isotopes—substances of the same chemical attributes, but of varying atomic weight—has thrown new light on the question. It is now recognised that the fractional values independently established in the case of any one element by the most accurate experimental work of various investigators are, in effect, " statistical quantities " dependent upon a mixture of isotopes. This result, indeed, is a necessary corollary of modern conceptions of the inner mechanism of the atom. The theory that all elementary atoms are composed of helium atoms, or of helium and hydrogen atoms, may be regarded as an extension of Prout's hypothesis, with, however, this important distinction, that whereas Prout's hypothesis was at best a surmise, with little, and that little only weak, experimental evidence to support it, the new theory is directly deduced from well-established facts. The hydrogen isotope, H_3, first detected by Sir J. J. Thomson, of which the existence has been confirmed by Aston, would seem to be an integral part of atomic structure. Rutherford, by the disruption of oxygen and nitrogen, has also isolated a substance of mass 3 which enters into the structure of atomic nuclei, but which he regards as an isotope of helium, which itself is built up of four hydrogen nuclei, together with two cementing electrons. The atomic nuclei of elements of even atomic number would appear to be composed of helium nuclei only, or of helium nuclei with cementing electrons; whereas those of elements of odd atomic number are made up of helium and hydrogen nuclei together with cementing electrons. In the case of the lighter elements

of the latter class, the number of hydrogen nuclei associated with the helium nuclei is invariably three, except in that of nitrogen, where it is two. The frequent occurrence of this group of three hydrogen nuclei indicates that it is structurally an isotope of hydrogen with an atomic weight of three and a nuclear charge of one. It is surmised that it is identical with the hypothetical "nebulium" from which our "elements" are held by astro-physicists to be originally produced in the stars through hydrogen and helium.

These results are of extraordinary interest as bearing on the question of the essential unity of matter and the mode of genesis of the elements. Members of the British Association may recall the suggestive address on this subject of the late Sir William Crookes, delivered to the Chemical Section at the Birmingham meeting of 1886, in which he questioned whether there is absolute uniformity in the mass of the atoms of a chemical element, as postulated by Dalton. He thought, with Marignac and Schutzenberger, who had previously raised the same doubt, that it was not improbable that what we term an atomic weight merely represents a mean value around which the actual weights of the atoms vary within narrow limits, or, in other words, that the mean mass is "a statistical constant of great stability." No valid experimental evidence in support of this surmise was or could be offered at the time it was uttered. Maxwell pointed out that the phenomena of gaseous diffusion, as then ascertained, would seem to negative the supposition. If hydrogen, for example, were composed of atoms of varying mass, it should be possible to separate the lighter from the heavier atoms by diffusion through a porous septum. "As no chemist," said Maxwell, "has yet obtained specimens of hydrogen differing in this way from other specimens, we conclude that all the molecules of hydrogen are of sensibly the same mass, and not merely that their mean mass is a statistical constant of great stability."[1] But against this it may be doubted whether any chemist had ever made experiments sufficiently precise to solve this point.

The work of Sir Norman Lockyer on the spectroscopic evidence for the dissociation of "elementary" matter at transcendental temperatures, and the possible synthetic intro-stellar production of elements, through the helium of which he originally detected the existence, will also find its due place in the history of this new philosophy.

Sir J. J. Thomson was the first to afford direct evidence that the atoms of an element, if not exactly of the same mass, were at least approximately so, by his method of analysis of positive rays. By an extension of this method Dr. F. W. Aston has succeeded in showing that a number of elements are in reality mixtures of isotopes. It has been proved, for example, that neon, which has a mean atomic weight of about 20.2, consists of two isotopes having the atomic weights respectively of 20 and 22, mixed in the proportion of 90 per cent. of the former with 10 per cent. of the latter. By fractional diffusion through a porous septum an apparent difference of density of 0·7 per cent. between the lightest and heaviest fractions was obtained. The kind of experiment which Maxwell imagined proved the invariability of the hydrogen atom has sufficed to show the converse in the case of neon.

The element chlorine has had its atomic weight repeatedly determined, and, for special reasons, with the highest attainable accuracy. On the oxygen standard it is 35·46, and this value is accurate to the second decimal place. All attempts to prove that it is a whole number—35 or 36—have failed. When, however, the gas is analysed by the same method as that used in the case of neon it is found to consist of at least two isotopes of relative mass 35 and 37. There is no evidence whatever of an individual substance having the atomic weight 35·46. Hence chlorine is to be regarded as a complex element consisting of two principal isotopes of atomic weights 35 and 37 present in such proportion as to afford the mean mass 35·46. The atomic weight of chlorine has been so frequently determined by various observers and by various methods with practically identical results that it seems difficult to believe that it consists of isotopes present in definite and invariable proportion. Dr. Aston meets this objection by pointing out that all the accurate determinations have been made with chlorine derived originally from the same source, the sea, which has been perfectly mixed for æons. If samples of the element could be obtained from some other original source, it is possible that other values of atomic weight would be obtained, exactly as in the case of lead, in which the existence of isotopes in the metal found in various radioactive minerals was first conclusively established.

Argon, which has an atomic weight of 39·88, was found to consist mainly of an isotope having an atomic weight of 40, associated to the extent of about 3 per cent. with an isotope of atomic weight 36. Krypton and xenon are far more complex. The former would appear to consist of six isotopes, 78, 80, 82, 83, 84, 86; the latter of five isotopes, 129, 131, 132, 134, 136.

Fluorine is a simple element of atomic weight 19. Bromine consists of equal quantities of two isotopes, 79 and 81. Iodine, on the contrary, would appear to be a simple element of atomic weight 127. The case of tellurium is of special interest in view of its periodic relation to iodine, but the results of its examination up to the present are indefinite.

Boron and silicon are complex elements, each consisting of two isotopes, 10 and 11, and 28 and 29, respectively.

Sulphur, phosphorus, and arsenic are apparently simple elements. Their accepted atomic weights are practically integers.

All this work is so recent that there has been

[1] Clerk Maxwell, art. "Atom," *Ency. Brit.*, 9th ed.

little opportunity, as yet, of extending it to any considerable number of the metallic elements. These, as will be obvious from the nature of the methods employed, present special difficulties. It is, however, highly probable that mercury is a mixed element consisting of many isotopes. These have been partially separated by Brönsted and Hevesy by fractional distillation at very low pressures, and have been shown to vary very slightly in density. Lithium is found to consist of two isotopes, 6 and 7. Sodium is simple, potassium and rubidium are complex, each of the two latter elements consisting, apparently, of two isotopes. The accepted atomic weight of cæsium, 132·81, would indicate complexity, but the mass spectrum shows only one line at 133. Should this be confirmed, cæsium would afford an excellent test case. The accepted value for the atomic weight is sufficiently far removed from a whole number to render further investigation desirable.

This imperfect summary of Dr. Aston's work is mainly based upon the account he recently gave to the Chemical Society. At the close of his lecture he pointed out the significance of the results in relation to the periodic law. It is clear that the order of the chemical or "mean" atomic weights in the periodic table has no practical significance; anomalous cases, such as argon and potassium, are simply due to the relative proportions of their heavier and lighter isotopes. This does not necessarily invalidate or even weaken the periodic law, which still remains the expression of a great natural truth. That the expression as Mendeléeff left it is imperfect has long been recognised. The new light we have now gained has gone far to clear up much that was anomalous, especially Moseley's discovery that the real sequence is the atomic number, not the atomic weight. This is one more illustration of the fact that science advances by additions to its beliefs rather than by fundamental or revolutionary changes in them.

The bearing of the electronic theory of matter, too, on Prout's discarded hypothesis that the atoms of all elements were themselves built up of a primordial atom—his *protyle*, which he regarded as probably identical with hydrogen—is too obvious to need pointing out. In a sense, Prout's hypothesis may be said to be now re-established, but with this essential modification—the primordial atoms he imagined are complex and are of two kinds—atoms of positive and negative electricity—respectively known as protons and electrons. These, in Dr. Aston's words, are the standard bricks that Nature employs in her operations of element building.

The true value of any theory consists in its comprehensiveness and sufficiency. As applied to chemistry, this theory of "the inner mechanism of the atom" must explain all its phenomena. We owe to Sir J. J. Thomson its extension to the explanation of the periodic law, the atomic number of an element, and of that varying power of chemical combination in an element we term valency. This explanation I give substantially in his own words. The number of electrons in an atom of the different elements has now been determined, and has been found to be equal to the atomic number of the element, that is to the position which the element occupies in the series when the elements are arranged in the order of their atomic weights. We know now the nature and quantity of the materials of which the atoms are made up. The properties of the atom will depend not only upon these factors, but also upon the way in which the electrons are arranged in the atom. This arrangement will depend on the forces between the electrons themselves and also on those between the electrons and the positive charges or protons. One arrangement which naturally suggested itself is that the positive charges should be at the centre with the negative electrons around it on the surface of a sphere. Mathematical investigation shows that this is a possible arrangement if the electrons on the sphere are not too crowded. The mutual repulsion of the electrons resents overcrowding, and Sir J. J. Thomson has shown that when there are more than a certain number of electrons on the sphere, the attraction of a positive charge, limited as in the case of the atom in magnitude to the sum of the charges on the electrons, is not able to keep the electrons in stable equilibrium on the sphere, the layer of electrons explodes, and a new arrangement is formed. The number of electrons which can be accommodated on the outer layer will depend upon the law of force between the positive charge and the electrons. Sir J. J. Thomson has shown that this number will be eight with a law of force of a simple type.

To show the bearing of this result as affording an explanation of the periodic law, let us, to begin with, take the case of the atom of lithium, which is supposed to have one electron in the outer layer. As each element has one more free electron in its atom than its predecessor, glucinum, the element next in succession to lithium, will have two electrons in the outer layer of its atom, boron will have three, carbon four, nitrogen five, oxygen six, fluorine seven, and neon eight. As there cannot be more than eight electrons in the outer layer, the additional electron in the atom of the next element, sodium, cannot find room in the same layer as the other electrons, but will go outside, and thus the atom of sodium, like that of lithium, will have one electron in its outer layer. The additional electron, in the atom of the next element, magnesium, will join this, and the atom of magnesium, like that of glucinum, will have two electrons in the outer layer. Again, aluminium, like boron, will have three; silicon, like carbon, four; phosphorus, like nitrogen, five; sulphur, like oxygen, six; chlorine, like fluorine, seven; and argon, like neon, eight. The sequence will then begin again. Thus the number of electrons, one, two, three, up to eight, in the outer layer of the atom, will recur periodically as we proceed from one element to another in the order of their atomic weights, so that any property of an element which

depends on the number of electrons in the outer layer of its atom will also recur periodically, which is precisely that remarkable property of the elements which is expressed by the periodic law of Mendeléeff, or the law of octaves of Newlands.

The valency of the elements, like their periodicity, is a consequence of the principle that equilibrium becomes unstable when there are more than eight electrons in the outer layer of the atom. For on this view the chemical combination between two atoms, A and B, consists in the electrons of A getting linked up with those of B. Consider an atom like that of neon, which has already eight electrons in its outer layer; it cannot find room for any more, so that no atoms can be linked to it, and thus it cannot form any compounds. Now take an atom of fluorine, which has seven electrons in its outer layer; it can find room for one, but only one, electron, so that it can unite with one, but not with more than one, atom of an element like hydrogen, which has one electron in the outer layer. Fluorine, accordingly, is monovalent. The oxygen atom has six electrons; it has, therefore, room for two more, and so can link up with two atoms of hydrogen: hence oxygen is divalent. Similarly nitrogen, which has five electrons and three vacant places, will be trivalent, and so on. On this view an element should have two valencies, the sum of the two being equal to eight. Thus, to take oxygen as an example, it has only two vacant places, and so can find room only for the electrons of two atoms; it has, however, six electrons available for filling up the vacant places in other atoms, and as there is only one vacancy to be filled in a fluorine atom the electrons in an oxygen atom could fill up the vacancies in six fluorine atoms, and thereby attach these atoms to it. A fluoride of oxygen of this composition remains to be discovered, but its analogue, SF_6, first made known by Moissan, is a compound of this type. The existence of two valencies for an element is in accordance with views put forward some time ago by Abegg and Bödlander. Prof. Lewis and Dr. Irving Langmuir have developed, with great ingenuity and success, the consequences which follow from the hypothesis that an octet of electrons surrounds the atoms in chemical compounds.

The term "atomic weight" has thus acquired for the chemist an altogether new and much wider significance. It has long been recognised that it has a far deeper import than as a constant useful in chemical arithmetic. For the ordinary purposes of quantitative analysis, of technology, and of trade, these constants may be said to be now known with sufficient accuracy; but, in view of their bearing on the great problem of the essential nature of matter and on the "superlatively grand question, What is the inner mechanism of the atom?" they become of supreme importance. Their determination and study must now be approached from entirely new points of view and by the conjoint action of chemists and physicists. The existence of isotopes has enormously widened the horizon. At first sight it would appear that we should require to know as many atomic weights as there are isotopes, and the chemist may well be appalled at such a prospect. All sorts of difficulties start up to affright him, such as the present impossibility of isolating isotopes in a state of individuality, their possible instability, and the inability of his quantitative methods to establish accurately the relatively small differences to be anticipated. All this would seem to make for complexity. On the other hand, it may eventually tend towards simplification. If, with the aid of the physicist, we can unravel the nature and configuration of the atom of any particular element, and determine the number and relative arrangement of the constituent protons and electrons, it may be possible to arrive at the atomic weight by simple calculation, on the assumption that the integer rule is mathematically valid. This, however, is almost certainly not the case, owing to the influence of "packing." The little differences, in fact, may make all the difference. The case is analogous to that of the so-called gaseous laws in which the departures from their mathematical expression have been the means of elucidating the physical constitution of the gases and of throwing light upon such variations in their behaviour as have been observed to occur. There would appear, therefore, ample scope for the chemist in determining with the highest attainable accuracy the departures from the whole-number rule, since it is evident that much depends upon their exact extent.

These considerations have already engaged the attention of chemists. For some years past a small International Committee, originally appointed in 1903, has made and published an annual report in which they have noted such determinations of atomic weight as have been made during the year preceding each report, and they have from time to time made suggestions for the amendment of the tables of atomic weights, published in text-books and chemical journals, and in use in chemical laboratories. In view of recent developments, the time has now arrived when the work of this International Committee must be reorganised and its aims and functions extended. The mode in which this should be done has been discussed at the meeting in Brussels, in June last, of the International Union of Chemistry Pure and Applied, and has resulted in strengthening the constitution of the Committee and in a wide extension of its scope.

The crisis through which we have recently passed has had a profound effect upon the world. The spectacle of the most cultured and most highly developed peoples on this earth, armed with every offensive appliance which science and the inventive skill and ingenuity of men could suggest, in the throes of a death struggle must have made the angels weep. That dreadful harvest of death is past, but the aftermath remains. Some of it is evil, and the evil will persist for, it may be, genera-

tions. There is, however, an element of good in it, and the good, we trust, will develop and increase with increase of years. The whole complexion of the world—material, social, economic, political, moral, spiritual—has been changed, in certain aspects immediately for the worse, in others prospectively for the better. It behoves us, then, as a nation to pay heed to the lessons of the war.

The theme is far too complicated to be treated adequately within the limits of such an address as this; but there are some aspects of it germane to the objects of this Association, and I venture, therefore, in the time that remains to me, to bring them to your notice.

The Great War differed from all previous internecine struggles in the extent to which organised science was invoked and systematically applied in its prosecution. In its later phases, indeed, success became largely a question as to which of the great contending parties could most rapidly and most effectively bring its resources to their aid. The chief protagonists had been in the forefront of scientific progress for centuries, and had an accumulated experience of the manifold applications of science in practically every department of human activity that could have any possible relation to the conduct of war. The military class in every country is probably the most conservative of all the professions and the slowest to depart from tradition; but when nations are at grips, and they realise that their very existence is threatened, every agency that may tend to cripple the adversary is apt to be resorted to—no matter how far it departs from the customs and conventions of war. This is more certain to be the case if the struggle is protracted. We have witnessed this fact in the course of the late war. Those who, realising that in the present imperfect stage of civilisation wars are inevitable, yet strove to minimise their horrors and formulated the Hague Convention of 1899, were well aware how these horrors might be enormously intensified by the applications of scientific knowledge, and especially of chemistry. Nothing shocked the conscience of the civilised world more than Germany's cynical disregard of the undertaking into which she had entered with other nations in regard, for instance, to the use of lethal gas in warfare. The nation that treacherously violated the treaty of Belgium and even applauded the action, might be expected to have no scruples in repudiating her obligations under the Hague Convention. April 25, 1915, which saw the clouds of the asphyxiating chlorine slowly wafted from the German trenches towards the lines of the Allies, witnessed one of the most bestial episodes in the history of the Great War. The world stood aghast at such a spectacle of barbarism. German *kultur* apparently had absolutely no ethical value. Poisoned weapons are employed by savages, and noxious gas had been used in Eastern warfare in early times, but its use was hitherto unknown among European nations. How it originated among the Germans—whether by the direct unprompted action of the Higher Command, or, as is more probable, at the instance of persons connected with the great manufacturing concerns in Rhineland, has, so far as I know, not transpired. It was not so used in the earlier stages of the war, even when it had become a war of position. It is notorious that the great chemical manufacturing establishments of Germany had been, for years previously, sedulously linked up in the service of the war which Germany was deliberately planning—probably, in the first instance, mainly for the supply of munitions and medicaments. We may suppose that it was the tenacity of our troops, and the failure of repeated attempts to dislodge them by direct attack, that led to the employment of such foul methods. Be this as it may, these methods became part of the settled practice of our enemies, and during the three succeeding years—that is, from April, 1915, to September, 1918—no fewer than eighteen different forms of poison—gases, liquids, and solids—were employed by the Germans. On the principle of Vespasian's law, reprisals became inevitable, and for the greater part of three years we had the sorry spectacle of the leading nations of the world flinging at one another the most deadly products that chemical knowledge could suggest and technical skill contrive. Warfare, it would seem, has now definitely entered upon a new phase. The horrors which the Hague Convention saw were imminent, and from which they strove to protect humanity, are now, apparently, by the example and initiative of Germany, to become part of the established procedure of war. Civilisation protests against a step so retrograde. Surely comity among nations should be adequate to arrest it. If the League of Nations is vested with any real power it should be possible for it to devise the means and to ensure their successful application. The failure of the Hague Convention is no sufficient reason for despair. The moral sense of the civilised world is not so dulled but that, if roused, it can make its influence prevail. And steps should be taken without delay to make that influence supreme, and all the more so that there are agencies at work which would seek to perpetuate such methods as a recognised procedure of war. The case for what is called chemical warfare has not wanted for advocates. It is argued that poison gas is far less fatal and far less cruel than any other instrument of war. It has been stated that "amongst the 'mustard gas' casualties the deaths were less than 2 per cent., and when death did not ensue complete recovery generally ultimately resulted. . . . Other materials of chemical warfare in use at the armistice do not kill at all; they produce casualties which, after six weeks in hospital, are discharged practically without permanent hurt." It has been argued that, as a method of conducting war, poison-gas is more humane than preventive medicine. Preventive medicine has increased the unit dimension of an

army, free from epidemic and communicable disease, from 100,000 men to a million. "Preventive medicine has made it possible to maintain 20,000,000 men under arms and abnormally free from disease, and so provided greater scope for the killing activities of the other military weapons. . . . Whilst the surprise effects of chemical warfare aroused anger as being contrary to military tradition, they were minute compared with those of preventive medicine. The former slew its thousands, whilst the latter slew its millions and is still reaping the harvest." This argument carries no conviction. Poison gas is not merely contrary to European military tradition; it is repugnant to the right feeling of civilised humanity. It in no wise displaces or supplants existing instruments of war, but creates a new kind of weapon, of limitless power and deadliness. "Mustard gas" may be a comparatively innocuous product as lethal substances go. It certainly was not intended to be such by our enemies. Nor, presumably, were the Allies any more considerate when they retaliated with it. Its effects, indeed, were sufficiently terrible to destroy the German *moral*. The knowledge that the Allies were preparing to employ it to an almost boundless extent was one of the factors that determined our enemies to sue for the armistice. But if poisonous chemicals are henceforth to be regarded as a regular means of offence in warfare, is it at all likely that their use will be confined to "mustard gas," or, indeed, to any other of the various substances which were employed up to the date of the armistice? To one who, after the peace, inquired in Germany concerning the German methods of making "mustard gas," the reply was: "Why are you worrying about this when you know perfectly well that this is not the gas we shall use in the next war?"

I hold no brief for preventive medicine, which is well able to fight its own case. I would only say that it is the legitimate business of preventive medicine to preserve by all known means the health of any body of men, however large or small, committed to its care. It is not to its discredit if, by knowledge and skill, the numbers so maintained run into millions instead of being limited to thousands. On the other hand, "an educated public opinion" will refuse to give credit to any body of men of science who employ their talents in devising means to develop and perpetuate a mode of warfare which is abhorrent to the higher instincts of humanity.

This Association, I trust, will set its face against the continued degradation of science in thus augmenting the horrors of war. It could have no loftier task than to use its great influence in arresting a course which is the very negation of civilisation.

The British Association at Edinburgh.

Abstracts of Presidential Addresses.

THE presidential addresses delivered at a meeting of the British Association are now published in volume form, thus providing a convenient annual record of authoritative thought and opinion upon a wide range of scientific subjects. The title of the volume just issued is "The Advancement of Science, 1921"; the publisher is Mr. John Murray, and the price 6*s*., or to members attending the Edinburgh meeting 4*s*. 6*d*. The address of the president of the Association, Sir Edward Thorpe, is also on sale separately, price 1*s*. Following our usual custom, we print this address in full in the present issue, and we hope, in succeeding issues, to publish the parts of addresses of presidents of sections of interest to scientific readers generally. The subjects dealt with in these addresses are described in the subjoined abstracts.

Problems of Physics.

In Section A (Mathematics and Physics) Prof. O. W. Richardson will review in his address the present state of a number of leading problems now engaging the attention of physicists. After a brief reference to relativity, the far-reaching importance of the discoveries relating to the nature of the nuclei of atoms being made at Cambridge by Sir Ernest Rutherford will first be emphasised. The conditions which govern the emission of electrons by matter will then be considered broadly. This involves a review of the present state of our knowledge of thermionic emission and of photoelectric action. These two groups of phenomena are shown to be very closely, perhaps inseparably, connected. Nevertheless, the claim that thermionic emission is merely a manifestation of the photoelectric activity of a body under its own thermal radiation will not withstand a critical examination. The same is true of the wider claim which has been put forward that all chemical action is a similar and immediate effect of radiant activity. There is not, in either case, enough radiation to produce the observed results. The controversy which has lasted more than a century as to the origin of contact potential differences will be referred to, and it will be shown that the new phenomena supply the material required to settle this dispute. All three groups of phenomena are, in fact, closely related, and have undergone similar vicissitudes. In conclusion, attention will be directed to the rapid unification of light and X-ray phenomena as the result of recent investigations.

Chemistry and Life.

Four years of warfare having given the public some insight into the relation between chemistry and industry, with perhaps undue stress on utilitarian aspects of the science, it appears desirable to emphasise also the fundamental part played

by chemical principles in the commonplace operations of daily life. This is done by Dr. M. O. Forster in his presidential address to Section B (Chemistry), entitled "The Laboratory of the Living Organism."

Illustrations are drawn from the marvellously interwoven stages of digestion and assimilation, from the purely chemical potentiality distinguishing animals from plants, and from the chemistry of the nucleic acids, the constitution and degradation of which have now been clarified by researches extending over the past fifty years. The present state of knowledge embracing chlorophyll and hæmoglobin is discussed, and is followed by a survey of the anthocyans, the pigments of blossoms and fruits. Attention is directed also to the diverse activities of micro-organisms and the need for systematic inquiry into the capabilities of those humble practitioners of the chemical art.

It is claimed that, by simple readjustments, the general scheme of secondary education could be made to include the principles of chemistry, physics, mechanics, and biology in quantity sufficient to render all intelligent citizens able to recognise, at least superficially, the miraculous transformations in which they take part, and which surround them on every side. Such a result would not only add enormously to the æsthetic value of life, but would provide the sympathetic and intellectual background for those who will, in the near future as history counts time, be called upon to surmount the real danger with which civilisation is threatened, namely, the continued failure of governments and people to realise that the worst enemy of man is Nature ignored or misunderstood, whilst his best friend is Nature studied and controlled.

Experimental Geology.

Dr. J. S. Flett's presidential address to Section C (Geology) deals with the subject of experimental geology. Of recent years a great and increasing amount of research has been done in determining the behaviour of molten silicates and other minerals when they are cooled and allowed to crystallise. By means of the electric furnace such experiments are now comparatively easy, and the electric pyrometer ensures accurate measurement of temperature. Many rock-forming minerals can thus be studied as regards their genesis and the conditions under which they are stable. Quartz, felspar, diopside, enstatite olivine, nepheline, wollastonite, tridymite, and many other components of igneous rocks can be produced in the laboratory. The action of gases can also be determined in apparatus specially designed to resist great pressure at high temperatures. Microscopic examination of the products has reached a stage of minute accuracy which greatly facilitates the interpretation of the results. We might almost regard this as a "new" petrology, but it is really a development of a method of inquiry which was initiated by Sir James Hall in the early years of the nineteenth century. Hall made experiments to prove that by slow cooling a molten basalt would consolidate, not as a glass, but as a crystalline rock. Afterwards he made a laborious investigation into the behaviour of chalk and limestone when heated in closed vessels, and succeeded in obtaining a crystalline marble. His results have been much discussed, and of recent years his experiments have been repeated with all the refinements of the modern laboratory. Hall's position as the founder of experimental geology has been vindicated, and his work remains a classic in this department.

Heredity, Environment, and Evolution.

Prof. E. S. Goodrich points out in his address to Section D (Zoology) that it is nearly one hundred years since Charles Darwin began his scientific studies in the University of Edinburgh. Certain problems relating to Darwin's doctrine of evolution still remain unsolved, and it is useful from time to time to re-examine the very foundations on which our theories are laid.

In trying to answer the question why some characters are inherited and others not, inheritance is defined as the reappearance in the offspring of a character possessed by the ancestor. Its constant reappearance is shown to be due neither to its age nor to its importance, but to the presence of both the germinal factors of inheritance and the environmental conditions or stimuli which co-operated in its formation in the parent. Characters are all of the nature of responses to stimuli which mould the course of metabolism. The factors alone are transmitted from parent to offspring in the germ-cells. The characters are produced anew at every generation. We should carefully distinguish between transmission and inheritance, and it is clear that whereas factors may be transmitted, characters as such never are.

There is no difference in kind or value between characters, and if some are inherited regularly and others not, the distinction lies in the constancy of the factors and conditions which give rise to them. There is only one kind of character, but there are two kinds of variation—modification due to change in the effective environmental stimuli, and mutation due to change in the complex of germinal factors. These variations must not be confused, as is so often done, with the characters that result from them.

The perpetual growth reproduction and transmission of the factors of inheritance (continuity of the germ-plasm) are but one aspect of the continuity of the metabolic processes at the basis of all the manifestations of life. Just as the various steps in the metabolic process are dependent on those which preceded them, so when an organism becomes differentiated into parts these react on each other and act as internal environmental stimuli, calling forth further responses which may modify the first. From chains of interdependent responses arise the power of individual adaptation and self-regulation. Whereas the lower organisms

develop to a great extent in response to external stimuli over which they have no control, the higher gradually substitute internal for external stimuli, thus acquiring considerable independence. Inheritance is made secure by ensuring that the necessary conditions are always present. The answer to the original question now appears to be that only those characters can be regularly inherited which depend for their appearance on conditions always fulfilled in the normal environment, external or internal.

Prof. Goodrich goes on to deal with the nature of the factors themselves, their relation to metabolism, and their possible alteration by the environment. How new factors are acquired is the fundamental problem of biology. Prof. M. F. Guyer's experiments are described. His remarkable results seem to show that an anti-body may be made to act on the germinal factors corresponding to its antigen, and that heritable mutations may thus be produced experimentally. A Lamarckian interpretation of these results is rejected.

In answer to the question, "What share has the mind taken in evolution?" it is pointed out that to the continuous physico-chemical metabolic process, describable in scientific language as a consistent series of events in an outside world, there corresponds a continuous series of mental events describable in psychical terms. The one is not a product of the other, nor does it control or interfere with the other; but confusion may arise because in a description of behaviour the gaps in our very incomplete knowledge of one series are usually filled in from the other. It is further pointed out that instinctive behaviour is carried out by a mechanism developed under the influence of stimuli, chiefly internal, which are constantly present in the normal environmental conditions, while intelligent behaviour depends on responses called forth by stimuli which may or may not be present. Hence the former is, but the latter may or may not be, inherited.

Finally, it is urged that these questions of factors and environment, heredity and evolution, are not of mere academic interest, but are of great importance for the progress of civilisation. Could we acquire the power to control and alter at will the factors of inheritance in domesticated animals and plants, and even in man himself, such vast results might be achieved that the past triumphs of the science would fade into insignificance.

Applied Geography.

Dr. D. G. Hogarth takes "Applied Geography" as the subject of his address to Section E (Geography). By this term is meant a loan asked of, or offered by, geography for the purpose of another science. It may be applied by students and teachers of the borrowing science, or by those of the lender; but if the latter devote themselves to such application they are for the time being seconded from their own sciences to the service of the others. Many geographers, especially in America, disagree with this view, holding such applications to be functions, even the main functions, of geography itself. If, however, the study of the "human response to land-forms" is the science of geography, that science is still in its earliest infancy! Geography has properly to consider man only from the point of view of his distribution over physical space; and study of the physical environment should precede the study of man in it. The prior importance of physical geography is not recognised in official curricula.

Geographical science is first and last the science of distribution. It includes the investigation, study of causation, survey, and diagrammatic delineation of all the superficial features of the earth. Of these, causation will be the last study to be exhausted. To the understanding of it many other sciences have to give help to geography, even as they ask her in turn to help them about the distribution of their own material. But it is, and will, remain a true function of geography. At the same time delimitation of geography from the sciences aiding it or aided by it is not easy, and has been obscured by progressive changes in the popular use of the word "geography," and by the continual parturition of specialisms by the latter, which come in time to be accepted as new sciences, but often remain for a while imperfectly detached from the mother. Such has been geodesy.

To teach geography, therefore, only in its application to history is not to teach geography as a science, and to do so discourages the study of the thing to be applied. This lessens the value of the application as much as it does the standard of geography proper. The Ministry of Education, the great scientific societies, and the universities must see to it that the study of the mother science is better encouraged, if many other sciences and much education are not to suffer.

Labour, Capital, and Wages.

The conclusions put before Section F (Economic Science and Statistics) by the president, Mr. W. L. Hichens, in his address, are as follows:—There is no simple and straightforward system applicable to the division of the proceeds of industry between labour and capital. Both are essential to industry, and, therefore, to each other; hence the deeper interests of both lie in co-operation, and the task before the leaders of labour and of capital consists in promoting the interests of both, not in selfishly pursuing the advantage of the one at the expense of the other. Both must recognise the need of contenting the other, for if capital is not satisfied its springs will dry up and the industrial body will wither away, whilst if labour is discontented and the members of the industrial body war against each other, the end is death. The real solution of the problem is a moral one, and can be achieved only if justice and virtue govern the lives of the members of the community, for all human organisations must re-

flect the character of those who work them. Arbitration offers no immediate solution of the difficulty, for to be effective it must be voluntarily accepted by the majority on both sides, and the principles by which arbitrators are to be guided must first be clearly expressed and accepted; but it is the goal at which civilisation must aim, and as a step in this direction public inquiries into all disputes between labour and capital should be encouraged after all attempts at mutual agreement have failed. A clearer understanding of economic truths in the industrial world is essential if disputes are to be avoided. It must be recognised that the wealth available for wages depends on the total production of the country, and that whilst, if production increases, wages will go up, if it falls wages must come down. So long as the present industrial system continues, the wages system must prevail, and profit-sharing is no substitute for it.

The fundamental wage, or the wage of unskilled labour, should be a living wage—that is, a wage suitable to the development of the physical, moral, and intellectual attributes of the citizens of a free country; but it must be recognised that the degree to which this ideal can be attained must depend on the skill and endeavour of the people, and due regard must be had to the progress, maintenance, and well-being of the industries of the country. It is idle to hope that the living wage can be based permanently on any given standard of civilisation; it is bound to fluctuate at different periods, and will depend largely on whether the industries of a country are progressive, stagnant, or retrogressive.

Water-power Development.

Prof. A. H. Gibson's address to Section G (Engineering) is devoted to a consideration of inland water-power and tidal-power development, with special reference to the possibilities in the United Kingdom and in the British Empire. The importance of water-power development, in view of the necessity for the conservation of solid and liquid fuels, needs no emphasis, and the extent to which such development has been taking place during recent years may be gauged by the fact that two-thirds of the water-power now being utilised throughout the world has been harnessed during the past decade. The proportion of the available water-power which is utilised throughout the British Empire is only slightly above 1 per cent. as compared with, approximately, 24 per cent. for the continent of Europe and for the U.S.A. The scope for further development in this field is obvious, and it should form a fruitful field of activity for British engineering for many years to come.

On the mechanical and electrical sides of water-power engineering the development has been rapid, and the modern turbine differs essentially from the types in common use a few years ago. Much investigation work in this direction is now in progress, and promises to give important results. Research in many other directions is also urgently required, and the importance is urged of instituting, on an adequate scale, a hydraulic laboratory at some institution of university standard for the special study of the many special problems now awaiting solution, a number of which are indicated in the address. The subject of tidal power is also considered briefly, with special reference to the problems still to be solved before any large scheme can be undertaken with confidence.

The Rôle of Physiology.

The relation of physiology to national life, to science generally, and to medicine in particular, is the theme of the address delivered by Sir Walter M. Fletcher to Section I (Physiology). Physiology, as we know it to-day, became established as a progressive branch of science when it was divorced from the study of anatomy just fifty years ago, when William Sharpey became professor of anatomy and physiology at University College, London, and to Sharpey and his personal influence the development of all the chief British, Canadian, and American schools of physiology can be traced. But until 1914 physiology had developed as one of the primary departments of knowledge chiefly in the older universities, where it was out of touch with the great centres of population and, in consequence, with medical needs. While this detachment allowed of a fuller and freer development of the subject, the urgent needs of humanity were not brought clearly before physiologists. The problems presented by the war served to remedy, in great measure, this defect. Changes in blood pressure and quality, the chemical mechanisms of the body, studies in heat loss and production in relation to climate, clothing, and diet, are some of the many "human" problems which had to be solved; the stresses and accidents of warfare provided an infinitely varied series of experiments on the human body. It also had a wholesome effect from its tendency to break down the barriers that had grown up between physiology and the practical needs of medicine.

The progress of physiology during the past half-century can be regarded alternatively as an analysis of the varied though inseparable functions of the parts of the body or as a synthesis leading towards the unification of the functions of all the parts in a single functional organism. The analysis has led to a growth of specialism within the mother-science, but there is a growing tendency to regard the whole organism as a physiological unit in relation to which alone the functions of the organs and their cellular subdivisions can find due expression.

At the present time there appears to be a danger that physiology will be confined to the medical schools, a fate which will limit its outlook by depriving it of co-operation with kindred sciences and tend to keep from it many promising recruits who are not contemplating medical studies. The

primary task of physiology is to enlarge the vision of man and enrich his knowledge of truth; to find power to diminish pain and restore health is a secondary task which must not be allowed to obscure the primary and greater aim.

Mind and Consciousness.

In Section J (Psychology) Prof. Lloyd Morgan deals with the status of mind and consciousness in what he speaks of as emergent evolution—the word "emergent" being here used in the sense suggested by G. H. Lewes in distinction from "resultant." In line with Prof. Alexander's treatment in "Space, Time, and Deity," ascending stages in evolution of (1) the physical, (2) the chemical, (3) the vital, and (4) the conscious are emphasised. In each a new "quality" is found and must loyally be accepted as given. But the physical and the conscious are regarded as heterogeneous in that the latter is felt or enjoyed. If we may infer that life process, as such, is accompanied by enjoyment, its affective integration may primarily be that to which the ill-chosen adjective "unconscious" should be applied. It is urged that since this word is "served with a negative prefix," it is imperative in some way to define the conscious. Differentiating criteria are suggested in the presence of some measure of (*a*) revival, (*b*) expectancy, and (*c*) objective reference. That which is unconscious is characterised by the absence of these criteria. The distinction between subliminal and supraliminal is, on this view, different from that between unconscious and conscious. There is much supraliminal enjoyment which is unconscious if these criteria of consciousness be accepted. It is keenly enjoyed, but without felt "againness" in revival or "comingness" in expectancy. In the development of consciousness, two levels are recognised: (1) the unreflective stage of naive perceptual cognition, and (2) the reflective stage of judgment where "values"—truth, beauty, and ethical goodness—are emergent. A distinction is drawn between scientific interpretation and metaphysical explanation. At any given level science interprets the emergent characters found therein as dependent on, but more than, those which obtain at lower levels; metaphysics interprets the lower in terms of that which is reached at a higher stage, and ultimately the highest. Each may be valid in its appropriate universe of discourse. They should be regarded as complementary and not antagonistic.

Plant Evolution.

The subject of Dr. D. H. Scott's address to Section K (Botany) will be "The Present Position of the Theory of Descent in Relation to the Early History of Plants." The first part of the address is concerned with general questions, and especially emphasises our present ignorance of the methods of evolution. The advent of genetics marked the end of the Darwinian period. The absence of satisfactory evidence of variation is pointed out, and attention is directed to the new theory of the origin of species by crossing. The prevalent attitude towards the doctrine of natural selection is briefly criticised. The essential service rendered to biology by genetics, in ensuring that organisms should be thought of as races rather than as isolated individuals, is recognised. The question of the conception of a "species" is touched on in passing.

The second and larger portion of the address is occupied with questions relating to the early history of plant evolution. Such inquiries, though necessarily speculative and, from a post-Darwinian point of view, more difficult than ever, are not regarded as hopeless. The transmigration from sea to land is discussed in the light of our newly acquired knowledge of an early Devonian land flora. The affinities of the Rhynie plants and their allies in relation to Pteridophyta, Bryophyta, and Thallophyta are considered, and the bearing of the new data on the homologies of the sporangium is indicated. The question of the existence of ferns in the older Devonian flora is discussed. The independence and antiquity of the seed-plant phylum are maintained, and in connection with this subject a brief sketch is given of our present knowledge of the Pteridosperms and of their relation to other Spermophytes. In conclusion, the current monophyletic and polyphyletic hypotheses of the origin of vascular plants are contrasted.

Education in Music.

Sir Henry Hadow urges in his address to Section L (Education) that music should be recognised in our formal education of school and college, and that it should be given a place in the curriculum and full recognition in the examination system. He suggests that music for the whole school should consist of little more than class singing and an occasional concert or lecture, and that those who have the taste and aptitude for pursuing its serious study should do so in substitution for some other subject. The study of a great composer might be made of as much educational value as that of a great poet. On the other side, the qualities of abstract thinking and of mental construction implied in the study of musical form are closely analogous to those of our natural sciences, and might well be made of the same educational value. It should be quite possible to draw up a syllabus for music which would fit into the existing schemes of school and college work, and would not encourage faddists, or excuse idlers, or produce that lamentable class of people, not yet quite extinct, who talk emotionally about music without any understanding. There should also be a great improvement in the place of music in our libraries. Every public library in the country, and, if possible, every school and university library, should contain a musical department which includes not only the standard classical compositions, but also the first-rate books on musical æsthetics and criticism. Moreover, our attitude towards music needs to be simplified. We want really to pool our knowledge, to concentrate our

interests, and to develop a sense of comradeship and co-operation, and this can be done only if we are all made free of the company—if our musical education is such that we can meet each other as frankly and openly in this field as educated men are accustomed to do in the discussion of science or poetry.

AGRICULTURAL ECONOMICS.

The address of Mr. C. S. Orwin to Section M (Agriculture) deals with the importance of the study of agricultural economics. It points out the overriding influence of the economic factor in all matters affecting the management and development of land. Soil, climate, and other factors have their importance, but the farmer can grow anything if there is a market for it, and his main consideration must be in all cases, not what will the land grow, but what can he sell at a profit to himself. Examples are given to illustrate the relatively small importance of soils and climate in crop production and the dominating influence of the market in combination with transport facilities.

Attention is also directed to the need for economic study in the organisation of farm management so as to prevent the wasteful application of one or more of the factors of production: land, capital, and labour. Thus a small farm may be made highly productive by a prodigal use of manual labour, but the same amount of labour applied to a larger area of land in conjunction with a bigger capital outlay on machinery equipment will increase the output per man employed, and it is suggested that production can be directed scientifically and to the general advantage only by a study of the three factors so as to use them in proper relation to each other.

The address aims at directing attention to the fact that the scientific research work in agriculture, which was first inaugurated publicly about twenty-five years ago, has taken no account of the need for the study of agricultural economics, and that agricultural research can never bear its proper fruit until investigations conducted along the lines of natural science are balanced by research work on an equal scale in agricultural economics.

SCIENCE AND CITIZENSHIP.

Sir Richard Gregory's "Message of Science," delivered to the Conference of Delegates of Corresponding Societies, is a plea for closer association between scientific workers and the rest of the community, as a means of promoting social well-being.

Civilised man has proved himself unworthy of the gifts which science has placed at his disposal, with the result that squalid surroundings and squandered life are the characteristics of modern Western civilisation instead of social conditions and ethical ideals superior to those of any other epoch. Responsibility for this does not lie with scientific discoverers, but with statesmen and democracy. Like the gifts of God, those of science can be made either a blessing or a curse, to glorify the human race or to destroy it; and upon civilised man rests the decision as to the course to follow. With science as an ally, and the citadels of ignorance and self as the objective, he can transform the earth; but if he neglects the guidance which knowledge can give, and prefers to accept the phrases of rhetoricians, this world will become a place of dust and ashes.

Unsatisfactory social conditions are not a necessary consequence of the advance of science, but of incapacity to use it rightly. Whatever may be said of captains of industry and princes of commerce, men of science cannot be accused of amassing riches at the expense of labour, or of having neglected to put into force the laws of healthy social life. Power—financial and political—has been in the hands of people who know nothing of science, not even that of man himself, and it is they who should be arraigned at the bar of public justice for their failure to use for the welfare of all the scientific knowledge offered to all. Science should dissociate itself entirely from those who have thus abused its favours, and not permit the public to believe it is the emblem of all that is gross and material and destructive in modern civilisation. It is the pituitary body of the social organism, and without it there can be no healthy growth, mentally or physically.

The Conference of Delegates provides an appropriate platform for this message of exhortation. There are now 130 Corresponding Societies of the Association, with a total membership of about 52,000, and their representatives should every year go back, not only strong with zeal for new knowledge, but also as ministers filled with the sense of duty to inspire others to trust in it.

The Present Position of the Wave Theory of Light.[1]

By DR. R. A. HOUSTOUN.

II.

WE come now to the fundamental difficulties. They have been stated very clearly by Dr. G. W. C. Kaye in his book on X-rays, and we shall borrow his method of presenting them:—

(1) When X-rays encounter a gas, only an exceedingly small fraction of its molecules becomes ionised.

(2) The extent of this ionisation is unaffected by temperature.

(3) When X-rays encounter a metal, the corpuscles ejected have a velocity which

(*a*) does not depend on the intensity of the X-rays, and so is independent of the distance of the metal from the X-ray bulb;

(*b*) increases continuously with the hardness, *i.e.* frequency, of the X-rays;

[1] Continued from p. 15.

(*c*) does not depend on the nature of the metal; and

(*d*) is equal to the velocity of the cathode rays in the X-ray bulb.

The last fact is a very striking one. To quote from the Robert Boyle lecture recently delivered by Sir William Bragg at Oxford (NATURE, May 19, p. 374):

> It is not known how the energy of the electron in the X-ray bulb is transferred by a wave motion to an electron in the photographic plate, or in any other substance on which the X-ray falls. It is as if one dropped a plank into the sea from a height of 100 ft., and found that the spreading ripple was able, after travelling 1000 miles and becoming infinitesimal in comparison with its original amount, to act upon a wooden ship in such a way that a plank of that ship flew out of its place to a height of 100 ft. How does the energy get from the one place to the other?

According to the discussion of these difficulties usually given, the X-rays should spread equally in all directions according to the wave theory. Consequently the few molecules which, according to (1), become ionised should be in some exceptional condition, *i.e.* have a high kinetic energy. But this energy cannot be ordinary heat energy, since according to (2) ionisation does not vary with temperature. It must be some store of internal energy of a radio-active nature, not readily unlocked by outside agencies. The X-ray thus acts as a trigger to start an explosion, of which the corpuscle is the outward and visible sign.

Why should the speed of the corpuscles depend on the wave-length of the X-ray, if the latter merely exerts a trigger action, and why is it independent of the distance of the X-ray bulb? Why is it independent of the nature of the metal? The difficulty of answering these questions in a satisfactory manner has led many to believe that the energy of the X-ray does not spread equally in all directions, but travels in a straight line, and is handed over completely to one corpuscle. Thus we had Bragg's corpuscular or neutral-pair theory of the X-ray and Einstein's quantum theory.

The case for a localised energy theory or entity theory, as it is called, for there are different names, appears at first sight to be strengthened by the numerical values of the quantities involved. The velocity of the cathode-ray particle, the X-ray it produces, and the velocity of the secondary corpuscle are connected by the equation

$$\tfrac{1}{2}mv^2 = hv,$$

where m is the mass of the cathode-ray particle or secondary corpuscle, v its velocity, h Planck's constant, and ν the frequency of the X-ray. Not only is there agreement between the value of h determined from this equation and the value derived from experiments on black body radiation, but there is extremely good agreement. In an article in the *Journal de Physique* for August, 1920, by M. de Broglie, who has himself added very considerably to our knowledge of both emission and absorption X-ray spectra, there is a description of the methods and a collection of results, from which it is evident that the differences are less than 1 per cent.

References have been made to Newton's emission theory. It is difficult for students to study this theory, as the "Opticks" has not been printed in English since 1730. A reprint is long overdue; the book is really accessible only in the German, in Ostwald's "Klassiker." There are quite erroneous ideas prevalent about the utility of Newton's emission theory for present-day purposes. Newton himself was not enthusiastic about it, and was cautious about using it. In the first sentence of the "Opticks" Newton says: "My design in this book is not to explain the Properties of Light by Hypotheses, but to propose them and prove them by reason and experiment," and he is very careful in pursuance of this design to make his statements as free from hypotheses as possible. Again and again he uses the word "ray" when it is obvious the thought in his mind is "stream of particles constituting the ray." But he eventually committed himself quite definitely. Light consisted of streams of particles, the violet rays being the smallest particles and the red rays the largest: the glass of the prism attracted the particles in the ray incident on it, and this attraction caused the deviation of the ray: the smaller particles were attracted more strongly than the larger particles, and consequently suffered a greater deviation: hence the formation of the spectrum. In order to explain interference Newton found it necessary to assume that the particles underwent periodic changes of state. These changes he referred to as "fits of easy reflection," because at the changes the particles were reflected more easily; the fits occurred at equal intervals along the path of the ray, and the length of these intervals varied with the colour; for the "rays which paint the colour in the confine of yellow and orange" the interval of the fits was 1/89,000 part of an inch, *i.e.* $2{\cdot}8 \times 10^{-5}$ cm.

But, though Newton adopted the emission theory, he had misgivings on the subject. This is especially evident from a query, No. 13, which he appends to the end of his "Opticks" as a problem suitable for future investigation. This query begins, "Do not several sorts of rays make vibrations of several bignesses, which according to their bignesses excite sensations of several Colours, much after the manner that the vibrations of the Air, according to their several bignesses, excite sensations of several sounds?" Then he suggests that the violet rays make the shorter vibrations, and the red ones the longer vibrations.

Newton's theory is, of course, so hopelessly inadequate for the explanation of interference, diffraction, changes of phase and amplitude, resolving power, etc., that no one has ever seriously thought of applying it to these fields of work. It even gives a wrong value for the pressure of light, a subject in which one would expect it to be at an advantage. The wave theory, on the other hand, holds an extremely strong position in these fields, a position much stronger than is imagined, for few workers at present experiment on such

things as, say, phase difference produced by total reflection, or conical refraction, and consequently there are not many people aware of the extremely high degree of agreement attained. It has not been quite so successful in dealing with the emission and absorption of light; this, however, cannot be ascribed so much to a defect of the theory as to our ignorance of the structure of matter.

Newton's theory being out of the question, and there being no definite alternative offered, we must attempt to explain the phenomena of X-ray energetics on the wave theory. This is not so difficult as is supposed, for in previous discussions important facts have usually been left out.

In the first place the wave theory does not limit us to the harmonic-wave trains of the elementary text-books. It certainly permits of the passage of energy in pulses which widen out very little as they travel. In some signalling experiments a beam of light has been used which was 2 in. wide at one end and 5 ft. wide at the other at a distance of five miles. There would be no difficulty in supposing this repeated on an atomic scale, if we could only imagine a mechanism for getting the beam started. Perhaps electrons vibrating with suitable phase differences on a space lattice might do. In any case it is a matter of arranging the interfering sources suitably; a hint to the properties of the Fourier integral is here enough. White light on the modern view consists of pulses, and we can easily make calculations on the interference, diffraction, and dispersion of such pulses. For example, a single pulse is changed by its passage through a dense flint plate of 1 cm. thickness into a group of about 500 visible waves.

Also it is not necessary that the pulse should be as narrow as the electron in order that all the energy in it should be absorbed by the electron. The analogy of a large metal plate coated with soot is very misleading in this respect. Lord Rayleigh has shown (*Phil. Mag.*, August, 1918), or at least made it plausible, that an electron captures all the energy passing through an area comparable with λ^2/π, where λ is the wave-length.

There is difficulty on the wave theory about starting the energy off along one line, since it would require elaborate and improbable conditions in the source. So it seems preferable to fall back on the other explanation, namely, that of "trigger action."

The spherical wave, uniform throughout its front and diverging from a single point source, is a mathematical fiction, used only in the interests of simplicity. What we have in reality is always a superposition of wavelets from a number of electrons, say n, included within a small region and vibrating simultaneously. These wavelets interfere. If their amplitudes were all the same and equal to a, the resultant intensity would vary from $(na)^2$ to 0, according to the degree of reinforcement present, the lower values being more probable and the average being na^2. There are thus singular points in the wave-front. The ionisation cannot depend on the intensity of the resultant wave, because this brings us up against the difficulty numbered 3 (*a*) above. As a result of the interference, though, changes of phase and different rates of change of intensity will be produced, and it is natural to suppose that some complicated combination of these produces the critical conditions; by an accurately timed series of impulses the electron is thrown out of its orbit, and an atomic explosion follows. Thus the objections above headed (1) and (2) are met.

The strongest argument in favour of the "trigger action" theory is undoubtedly the numerical value of Planck's constant itself. There has been comparatively little attention given to the meaning of the quantum itself, or to the connection between the atomicity of energy, or rather action it signifies, and the atomicity of electricity already established. The tendency has been rather to take the quantum for granted and to quanticise everything. There has also been a widespread assumption that the quantum is inexplicable in terms of the concepts already existing.

Suppose, however, that we take a sphere of positive electricity of uniform density ρ and radius a, and assume that inside the sphere there is one electron which oscillates about its centre through the positive electricity. Let ν be the frequency of the oscillations, and suppose the radius of the sphere just large enough to neutralise the electron. Then

$$\nu = \sqrt{\left(\frac{\rho e}{3\pi m}\right)} \text{ and } e = \frac{4}{3}\pi a^3 \rho.$$

Now suppose that the electron starts from rest on the surface of the sphere and falls towards the centre. Let v be the velocity acquired by the time it reaches the centre. Then $v = 2\pi a\nu$. On eliminating ρ and a these three relations give

$$v = \left(\frac{2\pi e^2}{m}\right)^{\frac{1}{3}} \nu^{\frac{1}{3}}.$$

If an electron has one quantum kinetic energy, its velocity is given by

$$v = \left(\frac{2h}{m}\right)^{\frac{1}{3}} \nu^{\frac{1}{3}}.$$

The difference between the two formulæ for v amounts to the sixth root of ν, an amount which would scarcely matter if only the visible spectrum were in question, but is much too great when we take the X-ray region also into consideration. But there is a surprising numerical agreement. If we fix our attention on two wave-lengths, (i) that of sodium in the visible spectrum, and (ii) the wave-length 10^{-8} cm. in the X-ray region, we find that the two expressions for v give in the case of (i) $9{\cdot}29 \times 10^7$ cm./sec. and $8{\cdot}64 \times 10^7$ cm./sec., and in the case of (ii) $1{\cdot}68 \times 10^9$ cm./sec. and $6{\cdot}64 \times 10^9$ cm./sec., the second value in each case being given by the quantum formula. Thus there is fair agreement for sodium, but the new formula gives only one-quarter of the correct value in the X-ray region.

The agreement, such as it is, cannot be a chance one. It means that if we construct a model atom in the simplest manner possible, so as to respond

to frequency ν, then the maximum internal energy of the system is of the order of the quantum corresponding to that frequency, and it inspires the hope that some day we may obtain a model which will give an exact agreement. In other words, this calculation gives us good reason for believing that when more is known about the constitution of matter it will be found that a frequency ν is specially qualified for unlocking the quantity of energy $h\nu$.

The difficulty labelled 3 (*c*) above requires that there should be electrons with a wide range of periods in all metals.

It should be remembered that the phenomena of X-rays themselves, the verification of the theory of scattering, the theory of the crystal lattice, etc., have given us a wide extension of the field of usefulness of the wave theory. It is, of course, nowadays extremely difficult to keep abreast of all the work that is being done even in one field; consequently, different workers attach different values to the facts, and there are many opinions on the points discussed here. But as yet there is no reason for physicists to make any essential change in their attitude towards the wave theory, and in any case it does not conduce to clear thinking to use two mutually contradictory metaphors at the same time.

It is a curious fact that if Euclid does not deserve so much credit for his postulate of parallels as was formerly supposed, he may, on the other hand, lay claim to foreshadowing one feature of some modern views on light. For, according to his "Optics" (*circa* 280 B.C.), he thinks that there are gaps between the rays, that they are localised like the spread-out fingers of a hand; when the observer fails to perceive a small object like a needle lying directly in front of his nose, it is because the needle has got into one of the gaps between the rays.

Classical and Modern Education.[1]

By W. Bateson, F.R.S.

FOLLOWING that general misgiving as to our national system of education which, long felt by thoughtful men, found loud and continual expression during the war, Mr. Asquith, then Prime Minister, appointed (1916) Committees to consider the position of natural science and of modern languages respectively. After these Committees had reported, a third Committee was set up (1919) to investigate the position of classics in our educational system. The Report of this Committee, recently issued, is a comprehensive document, full of interesting materials, readable and scholarly, as from the character of the Committee might be expected. The history of classical teaching in the several parts of the United Kingdom, its rise and recent decline, are set out in detail, with an abundance of information never before collected. As to the main inference, no mistake is possible. The classical element in British education is disappearing, and will probably soon be gone altogether.

> In the Public Schools few boys are learning Greek, and even Latin, though still generally taught in middle and lower forms, tends more and more to be dropped higher up. None of the new Provided Schools has yet been able to develop a classical tradition and few of them teach Greek. . . . The danger with which we are faced is not that too many pupils will learn Latin and Greek, but that the greater part of the educated men and women of the nation will necessarily grow up in ignorance of the foundations on which European society is built.

The course of events has been exactly that which the defenders of compulsory classics at Oxford and Cambridge foresaw as the consequence of any weakening of front. Classics were maintained in education solely by the authority of the two old universities. Fearing the financial consequences of competition, they reduced the minimum demanded until it became ridiculous, the inevitable result being that Greek had to be dropped, with Latin soon to follow. The reformers were, of course, mostly persons who set no great store by classical education, but they were aided by many representatives of the humanities, who believed, or were persuaded, that the inherent value of classical training was so obvious that it would hold its own without protection. They forgot that, on their abdication, the decision would pass into the control of those who knew the classics only as a symbol of exclusion, with the Board of Education naturally well disposed towards any movement which could be represented as popular.

Probably emanating from that group of the reformers, there are passages in the Report which maintain an undertone of hope. Wonders have been achieved by a few resolute and devoted scholars in some of the most modern universities. This is "of good augury," and "with the enthusiasm born of free choice of subject" there may yet be a revival. Numerous recommendations on points of detail are suggested to this end. The regulations, especially those relating to "Advanced Courses" in secondary schools, and the examination schedules should not be weighted unduly against the classics. In every large district there should be at least one school where Greek teaching can be had and provision is made for boys and girls with literary tastes, and generally the Committee pleads that in every branch of educational administration classical education should be respected as a thing of great worth.

The value of the classics has never been better

1 "Classics and Education." Report of the Committee appointed by the Prime Minister to inquire into the Position of Classics in the Educational System of the United Kingdom. Pp. 308. (London: H.M. Stationery Office.) 2s. net.

set forth. This part of the Report is admirable good sense, and approaches to eloquence as nearly as a Report to a Prime Minister can do. In the classics a man "obtains access to literature, both in prose and poetry, which in the judgment of many is absolutely the noblest in the world; but if that claim be not admitted, it is at least unique, inimitable, and irreplaceable. We have here a spiritual value not easily reckoned. . . ." Not merely are the works of antiquity "classic in the sense that they belong to the highest class of human achievement," but they have the peculiar merit of introducing the student to a world which is not our own, though presenting problems closely akin to ours, thus promoting a certain power of understanding and of judgment in fundamentals. The student has "attained this access to beauty and this power of understanding by means of a peculiar course of training which requires the exercise of many different powers of the mind, and forms a remarkable combination of memory-training, imagination, æsthetic appreciation, and scientific method. For better or worse, the study of the classics is quite a different thing from the learning of languages pure and simple." Even the merely verbal exercises start the "invaluable habit of thinking out the real meaning of words and phrases before attempting to translate them." The exposure of the inadequacy of translations is especially convincing. "Few people would seriously maintain that we can get 'all we want' out of an English translation of Victor Hugo or Goethe, or a French translation of Shakespeare or Burke."

The attitude of the Committee towards grammar is symptomatic of a welcome change. Hitherto the classical teacher has refused to put grammar anywhere but first. He would surrender nothing. By this pedantry thousands have been repelled. No one doubts that grammatical exercises are a fine educational instrument, but in comparison with the rest that classical education can do, grammar is such a small, poor thing. Had the scholastic world repented of this error when the warning came, the classics might have survived as the staple of at least a complete education. The remarks of the present Committee on methods of teaching are all that could be wished. It is advised that "great stress should be laid on the subject-matter and the historical background of the texts read, though not to the prejudice of exact training in the language." We may be thankful for this concession to common sense.

Probably it comes too late. Time was when modern languages, and especially science, were admitted grudgingly, and could be treated with scant respect. There is a sadly humbled tone now, and the classical apologist comes delicately before his judges. All he begs for is an equal chance; for instance, that in the "first examination" the requirements in other subjects should not be so exacting as to discourage the candidates from offering at least Latin as well as one modern foreign language, and that natural science should not be made compulsory.

It is true that the classics offer an access to beauty and give a power of understanding which nothing supplies so readily and so well, but the members of the Committee are sanguine men if they expect their recommendations to be adopted. The mind of the country is set on other things. "The civilisation of the modern Western world is grounded upon the ancient civilisation of the Mediterranean coast," as they rightly say in their exordium. The understanding of those who know nothing of these origins is hopelessly imperfect and starved. To this theme the Committee often recurs. The members have had the good fortune to meet with much evidence indicating a growing appreciation of the value of the classics, which is epitomised in striking passages of the Report. Mr. Mansbridge is quoted to the effect that a widespread demand for classical teaching may be expected amongst working people, who are greatly interested in the civilisation of Greece, "in spite," as he adds, "of deep-rooted prejudice against a nation which had such a sharp division of the classes"—a naive and significant illustration of the instructive value of classical experience. The social reformer may learn something by contemplating the peculiar and, as he holds, reprehensible system of Athens, a spectacle from which he naturally shrinks, as the feminist might from inspecting the dreadful example of the termite queens, or the hen hornbill plastered into the nest by her husband.

The Committee is under the impression that the scientific world especially concurs in its opinion. It is very doubtful whether the representatives of labour or of science who testified before them are truly representative of the mass with whom authority now rests. As the Committee remarks in another place, discussing the policy of the local education authorities, "it is unlikely that any body of ratepayers would consent to special financial provision for the encouragement of classics." It is: most unlikely. Let them raise the question in any place of common resort, or even, say, at a laboratory tea, and they will carry away no illusions about growing appreciation of the classics. They will find themselves in a world which cares not a jot that "all our modern forms of poetry, history, and philosophy" originated with the Greeks, and has only a scant curiosity as to whether Western civilisation is grounded on that of the Mediterranean or of some other coast. So complete is the break already that the younger students scarcely know that classical education can be seriously defended, and regard any tenderness for it as mere perversity and affectation. We are probably witnessing that rare and portentous event, a break in the continuity of civilisation. In the Press, in the arts, and, most singular of all, in learning of various kinds, the same phenomenon appears. The modern room of a picture gallery tells the same story as the pages of a scientific periodical. The new generation means

to go a lot more easily than the last. Precision of language and finish are out of fashion and superfluous; as they would say, they have no use for them. A narrower range suffices. Any deep background of knowledge is only a source of perplexity. Richness and abundance are uncongenial to modern pragmatism. A simpler diet, consisting largely of ready-prepared and familiar substitutes, such as home provides, is preferable. All this is very curious and most interesting to observe. The world may become more contented, but it is likely to be duller, and that simultaneously with these changes a revival of interest in the classics can occur seems highly improbable.

The Report betrays a consciousness that the subject dealt with is one wider than the nominal problem of classical education, and the members of the Committee know that they are in reality pronouncing on a great social question. They are haunted by timidity and obsessed with the democratic nostrum of equal rights and opportunities; but, though fighting for their lives, they dare not make a firm stand. They should have declared boldly that learning, classical and natural, though comprising many parts, is one indivisible whole. Never was it so urgently necessary that the unity of the intellectual world should be maintained and strengthened. The natural and permanent division of society is between them and the rest. Instead of seeing in science a competitor, the classical advocates should have welcomed natural knowledge as an indispensable and essential part of complete education. Spontaneous curiosity is, as they truly say, the only safe foundation for the continuous life of any study; but curiosity is a function of active minds, which alone are entitled to the privilege of direction. Freedom of choice is a counsel of perfection; a mere vanity unless the choosers have themselves wisdom, and the knowledge by which choice must be guided. In default, the decision must be made by informed authority, and must be enforced by compulsion.

If the continuity of civilisation is to be preserved, there can be no question of abandoning the classics, but in the name of truth and advancement no less must science be presented to all who pretend to complete education. They must acquire a "widespread knowledge, however elementary, of the ancient world," and an equally widespread knowledge of the elements of natural truth. The rudiments of classics, of natural science, and of a modern language can be easily mastered by any boy of ability before he is seventeen. The feebler will no doubt drop behind. They will find their place below.

Notes.

A COMMITTEE has been appointed by the Home Secretary to re-examine, more particularly in the light of the further information which has become available since the inquiries of the Departmental Committees appointed in 1911, the question of the danger from the use of lead paints to workers in the painting trades, and the comparative efficiency and cost, and the effect on the health of the workers, of paints containing lead and leadless paints respectively; and to advise whether any modifications of the conclusions and recommendations of those Committees have become necessary. The members of the Committee are:—Sir Henry Norman, Bart. (chairman), Mr. G. Bellhouse, Dr. O. J. Kauffmann, Dr. T. M. Legge, Mr. A. E. Munby, Dr. A. Scott, and Mr. H. O. Weller. The secretary is Mr. C. W. Price, of the Home Office, Whitehall, S.W.1, to whom any communications should be addressed.

THE Air Ministry has accepted the offer of Sir Ernest Shackleton to carry out meteorological investigations and to gather topographical information during the forthcoming expedition in the *Quest*, and is affording all necessary assistance to the expedition in order that as complete information as possible may be collected. The expedition has been furnished with instruments and equipment necessary for carrying out meteorological observations, and the *Quest* has been constituted an official reporting ship of the Meteorological Office. The vessel has also been supplied with photographic apparatus and with kites similar to those employed in the investigation of the upper air over the Atlantic during the voyage of the s.s. *Montcalm* before the Transatlantic flight of the R34 in 1919. It is further proposed to take records of the temperature and pressure of the upper air by using a seaplane which is to accompany the expedition.

NEWS from the Mount Everest Expedition in Col. Howard Bury's dispatch to the *Times* is dated from Kharta, August 4. The northern and north-western sides of the mountain appeared to offer no practicable means of ascent, and the southern side is flanked by great precipices. In the hope of finding a way on the eastern side the expedition moved its base from Tingri to Kharta. The route was by Netsogu, Rebu, across the Doyala River to Chongpu, where a region of luxuriant vegetation was reached. The new camp appears to be in the Arun Valley and is placed on an old river terrace with fine views up and down the valley. Its altitude is about 12,300 ft. A mile below the camp begin the deep gorges of the Arun. Mr. Mallory and Mr. Bullock rejoined the expedition *en route*, bad weather having compelled them to give up their plan of trying to reach Kharta by the high pass north of Mount Everest. On August 2 they began the exploration of the eastern approaches of the mountain. The weather in August was bad, but better conditions were expected in September. Yet, in spite of these difficulties, more than 9000 miles of new country have now been mapped.

THE report of the Science Museum at South Kensington for 1920, which has recently been pub-

lished, records the re-opening of a portion of the galleries which had been closed to the public for four years in consequence of their being occupied for the purposes of the war. But although this has rendered it possible to re-arrange some of the collections of scientific instruments and apparatus, the museum as a whole is very seriously handicapped by the inadequacy of its accommodation, which is but a third of what a committee reported in 1911 to be immediately necessary for the adequate display of the collections. A considerable number of collections have consequently been withdrawn from the exhibition galleries and placed in store, where they can be seen by visitors who express a desire to consult them. In all sections very considerable additions have been made, including a Newcomen pumping engine of 1791, a group of two hundred models of historical warships, a number of aeronautical engines, also a gravity torsion balance of the pattern designed by the late Baron R. Eötvös and the microscope by Powell and Lealand which gained the premium offered by the Royal Society in 1843. The number of visitors showed a considerable increase, but until the new museum buildings are made available the museum will become increasingly inconvenient for visitors on account of the extreme congestion of the exhibition galleries. Additions to the collections are constantly being made by gifts and loans of objects of historical or technical importance, but their instructional value is greatly diminished by the impossibility of displaying them adequately under existing conditions.

THE crafts of spinning and weaving have long been practised in the Sudan. Fragments of fine linen found by Dr. Reisner at Kerma have been dated about 2000 B.C., and he thinks that they were certainly woven in the country, though possibly by some Egyptian workmen attached to the household of one of the great noblemen who administered the country. But the manufacture of fine linen has disappeared; the modern craft is carried on in a very simple way, and the craftsman is not held in honour. A useful account of spinning and weaving at the present day is supplied in vol. 4, No. 1, April, 1921, of *Sudan Notes and Records* by Mrs. I. W. Crowfoot, who gives a full account of the appliances used, and compares them with those described by Mr. H. Ling Roth in his valuable "Studies in Primitive Looms" (Journal of the Royal Anthropological Institute, vol. 47, 1917). The trade of thread- and cloth-making has been for some time moribund in the Sudan, and Mrs. Crowfoot pleads for its encouragement as a trade for boys and as a homecraft for girls, particularly in view of the high prices and low quality of the machine-made textiles, which alone at present supply the needs of the people of the Sudan.

SMUGGLING of drugs, such as morphia, cocaine, raw opium, and Chandu, or opium prepared for smoking, is strictly forbidden in the Federated Malay States, but, as might have been expected, the prohibition has led to the use of many ingenious devices by the Chinese and Malays to evade the revenue authorities. A full list of these, with sketches, is given by Mr. W. G. Stirling in the Journal of the Straits Branch, Royal Asiatic Society, April, 1921. Clothes and walking-sticks, soles of shoes, dried walnuts, dead ducks, the dovetailing of a cabinet, a stack of saucers, a sitting hen on her eggs, a pail of rice—all have been used in some clever way for the storage of contraband Chandu.

THE influence of alcoholic grandparents upon the behaviour of white rats is the subject of an interesting paper by Messrs. E. C. Macdowell and E. M. Vicari (*Journ. Exper. Zoology*, vol. 33, No. 1, 1921, p. 209). A series of rats was alcoholised, and the grandchildren were subjected to a series of tests on finding their way in a circular maze provided with doorways, blind alleys, mirrors, etc. From the point of view of learning their way to the centre and going there for food, the test rats were found to be less successful than the controls. If this be true, a modification of the genetic basis of inheritance has been demonstrated.

THE REV. F. C. R. JOURDAIN, leader of the Oxford University Expedition to Spitsbergen, tells a woeful tale in the *Times* of August 25 of the depredations of egg-collectors among the nesting-birds of Spitsbergen. The introduction of oil-engines into sealing sloops has enabled them to work practically the whole of the west and north coasts of Spitsbergen with little danger of their being trapped by drift-ice. They have thus been able systematically to clear the nests of the large colonies of eider-ducks breeding there. One boat was met which had 15,000 eggs of the eider-duck on board! Examination of the colonies showed that the vast majority of the nests contained one or, at most, two eggs. With the brent goose the state of things was even worse. The large colonies which were known to nest on some of the eider holms as lately as 1908 have disappeared entirely, and the survivors scattered to nest in isolated pairs on the mainland, there to fall victims to the Arctic fox. Colonies of eider-ducks on the more inaccessible parts of Spitsbergen provided a welcome contrast. Here the nests contained an average of six eggs each, the largest number in a single nest being thirteen, and the busy scene of life on an untouched eider colony provided a glimpse of the Spitsbergen of the past, before the coming of the oil-engine and the coal prospector. The article is illustrated by admirable photographs of nesting birds obtained by the party.

THE American marsupial Cænolestes has always been something of a puzzle to students of mammalia, being variously regarded as a diprotodont, as a special type of subordinal rank the diprotodont characters of which are convergent, and as an aberrant polyprotodont. In view of such divergent views on its affinities, a more detailed study of its characters was desirable, and Mr. W. H. Osgood has supplied this need (Field Museum of Natural History, Zoological Series, vol. 14, No. 1). He regards Cænolestes as a surviving member of an ancient group, retaining many primitive features and exhibiting no marked degree of specialisation. It bears no special affinity to the American Didelphyiidæ, but shows many resemblances to the Australian peramelids, though it has advanced

beyond them to greater morphological similarity with the specialised diprotodonts. Its ancestor was probably a northern form which had already separated from the generalised polyprotodont stock, possibly extended all over Holarctica, and may, therefore, have given rise to the Australian diprotodonts. Mr. Osgood is therefore led to support the Holarctic origin of the mammalia so powerfully advocated by Matthew in 1915. He concludes that Cænolestes must be classified as a diprotodont marsupial belonging to a special subfamily of its own in the family Palæothentidæ, the approximate position assigned to it by Osborn in 1910, but suggests that, in view of its resemblances to the peramelids, it may be necessary later to remove the latter from the polyprotodonts and to unite them with Cænolestes in a special group of equal value with the Australian Diprotodontia and the remaining Polyprotodontia. Mr. Osgood's conclusions are supported by Prof. C. J. Herrick from a study of the brain of Cænolestes. His results, published as an appendix to Mr. Osgood's work, show that the brain of Cænolestes resembles most closely those of Perameles and Notoryctes, and is more simply organised than that of any Australian diprotodont.

THE Note of the Financial Adviser to the Egyptian Government on the Budget of 1921–22 (Cairo, May, 1921) is of interest for the stress which it lays on the importance of scientific research in Egypt. A country of a restricted habitable area and with a population ten times as large as it would naturally support needs all the assistance that scientific knowledge and technical skill can give. The importance of conducting research in various fields is so great, and its omission will be so dearly paid for, that nothing should be allowed to hamper its steady prosecution. The spheres in which such investigations are already proceeding are principally the study of the Nile and the rainfall which feeds it; the improvement of the cotton plant; the prevention of disease among the population, and the application of the knowledge which has been gained of bilharzia and ankylostoma to the improvement of village life; the study of the fish-life in the lakes, waterways, and territorial waters of the country as bearing on an important food-supply which could be largely developed; and the exploration of the desert regions for further deposits of petroleum, since Egypt is otherwise dependent upon imported fuel. Registration of title to land has become an urgent need, not only to facilitate transactions in landed property, but also to enable re-assessments of land tax to be made rapidly, and to provide the means of quickly and accurately collecting crop statistics, which are of the greatest importance, not only to the agriculturist, but also to the irrigation engineer who has to distribute the water, and to the Government in the interest of public economy and of public finance. There is probably no country where properly directed scientific research gives so prompt and abundant a return for expenditure made upon it as Egypt.

THE Nile Commission during its sittings in Cairo last year received a memorandum from a committee of Egyptian engineers which dealt with various matters relating to the irrigation projects under consideration by the Commission. The committee has now published an English translation of a communication which it has forwarded to Adly Yeghen Pasha, the Egyptian Prime Minister, in which it criticises some of the conclusions of the Commission. The principal contentions would appear to be that the additional water required for Egypt can be stored by a heightened Aswan Dam; that Egypt has a claim to all the water she requires or may require before the Sudan can use the supply which flows through it; and that irrigation works in Egypt itself are more important than the proposals for utilising the Nile supply as a whole. The outlook seems to be rather too narrow a one, for the subject needs to be examined in all its bearings, agricultural as well as irrigational, while the ever-increasing demand for water necessitates accurate hydrographical studies of the whole basin. We understand that the Egyptian Government has appointed a Special Committee to study the whole question in all its bearings, and to recommend how the various interests can best be served. Mr. C. E. Dupuis, formerly Inspector-General of Sudan Irrigation and Water Adviser to the Egyptian Ministry of Public Works, will be the chairman, and will be assisted by scientific and technical members. This Committee will doubtless examine carefully and critically the proposals which the committee of Egyptian engineers is supporting.

MR. ALEX. B. MACDOWELL has examined the records of temperature at Greenwich with regard to the incidence of very warm and very cold months in the seven years of sun-spot maxima, 1848–1917, and the same number of years of sun-spot minima, 1843–1913. Taking a very warm month as one with mean temperature more than 3° above average and a very cold month as one more than 3° below, he finds thirteen very warm months and twenty very cold ones (thirty-three together) in the years of maxima of sun-spots as compared with four very warm and nine very cold (thirteen together) in the years of minima. In sending us a communication on this subject Mr. MacDowell asks:—"How is it that both very warm and very cold months turn up so much more frequently when the sun is disturbed than when it is quiet?"

CLIMATOLOGY in California is dealt with in the U.S. *Monthly Weather Review* for April, 1921, by Mr. A. H. Palmer, Meteorologist to the Weather Bureau at San Francisco. Eleven regular first-class stations are maintained in the State, and there are also about three hundred climatological sub-stations, at most of which the observers are voluntary. Special attention is paid to precipitation data, this being the most important element of climate in California. Various educational and research institutions also maintain climatological stations. The University of California has four precipitation and two evaporation stations. Certain stations are maintained primarily for agriculture; nearly all the large citrus-growing regions have climatological stations, and the instruments are usually situated in or near the fruit groves.

Climatology has contributed largely to the successful introduction of the date-palm, for this tree requires tropical or semi-tropical weather conditions and very little water; the palms will flourish in what appears to be a sandy desert provided the temperature conditions are favourable. About two hundred and fifty Southern Pacific railway station agents also keep temperature and precipitation records. The author mentions that a San Francisco instrument manufacturer has sold more than a thousand rain-gauges, and rainfall records are readily maintained.

TECHNOLOGIC Paper No. 192 of the Bureau of Standards, Washington, consists of an account by Dr. G. K. Burgess, of the Bureau, of the tests of six hollow cylindrical steel castings manufactured by the centrifugal process. The castings were 6 ft. long and of diameters up to 18 in., with holes of various diameters through them; they were made with the mould revolving about the axis at a speed not specified. Samples of the metal taken from different parts of the complete castings were tested for hardness, tensile strength, soundness, structure, and density, both in the condition as cast and after heat treatment of various kinds. It was found that there was a slight segregation of carbon, phosphorus, sulphur, nickel, and copper in the radial direction, but none of manganese and silicon. Small blowholes were evident in the inner 1/16 in. of the castings. After heat treatment several of the castings showed mechanical strength equal to forged materials of the same composition, and satisfied the ordnance requirements for gun forgings. Microscopic examination showed no hard spots, flaws, or other defects outside the layer 1/16 in. thick at the inner surface, and the process appears to be one of great promise.

MESSRS. DUCKWORTH AND CO. include in their autumn list of forthcoming books "The Wheat Plant: A Monograph," by Prof. J. Percival. Part 1 will deal with the botany of the plant and its various parts, and part 2 with the methods of cultivation of the different varieties, with chapters also on hybridisation, breed, and yield. Another work promised by the same publishers is "The Great White South: Being an Account of Experiences with Captain Scott's South Pole Expedition, and of the Nature Life of the Antarctic," by H. G. Ponting, with an introduction by Lady Scott.

THE Cambridge University Press is bringing out in the autumn for Major Leonard Darwin a small work entitled "Organic Evolution: Outstanding Difficulties and Possible Explanations," being a collection of brief notes on biological matters arising from "The Origin of Species."

Our Astronomical Column.

THE AUGUST METEORIC DISPLAY.—Another proof of the unusually abundant display of August meteors belonging to the Perseid shower is provided by observations made by Mr. P. Meesters at Halfweg (near Amsterdam–Haarlem), Holland, with an outlook from north-west by north to east.

On August 11, watching from 9.15 until 11.15 A.M.T., Mr. Meesters counted twenty-eight meteors, viz. 2, 3, 4, 2, 1, 5, 7, 4, during each quarter of an hour. On August 11, watching from 9.15 until 10.15 A.M.T., thirty-nine meteors were seen, viz. 6, 17, 9, 7. At 9.29 A.M.T., in two seconds, four meteors were seen equal to Venus or Jupiter. Clouds came over the sky at 10.15 A.M.T. From 11.30 until 1.45 A.M.T. Mr. Meesters counted 286 meteors, viz. 60, 68, 54, 50, 54, in each quarter of an hour. On August 12, watching from 9.15 until 10.15 A.M.T., he counted 4, 7, 6, 1 objects in each quarter of an hour; clouds coming over the sky prevented further observations. On August 13, from 1.45 until 2 A.M.T., three Perseids were seen between drifting clouds. Several of the Perseids were equal to, or brighter than, stars of the first magnitude. The maximum display was thus in the latter part of the night of August 11.

THE BRIGHT OBJECT NEAR THE SUN.—Two observations of this object were made in England on August 7, some hours before that at Mount Hamilton. The first (communicated by Col. Markwick) was made by Lieut. F. C. Nelson Day and others at Ferndown, Dorset, about 7h. G.M.T. Its magnitude was estimated as *minus* 2 and its distance from the sun as 4°.

Mr. S. Fellows observed it at Wolverhampton with binoculars shortly after sunset (*Eng. Mech.*, August 19). He noted it as reddish, elongated towards the sun, from which it was distant 6°. The estimates of distance are probably too rough to use for the deduction of motion. It may be noted that a comet with retrograde motion near the plane of the ecliptic and small perihelion distance approaching the sun from behind might remain in close proximity to it the whole time that it was bright.

Astr. Nach. No. 5116 contains full particulars of the luminous bands seen at the Königstuhl and Sonneberg Observatories on August 8d. 12h. G.M.T. It appears probable that they were auroral, especially as Prof. M. Wolf noted a similar appearance on August 5, 11h. 15m. to 11h. 36m. G.M.T. It was "a long, very bright cloud west of the Pleiades, brightest near δ Arietis . . . it faded rapidly, only a trace visible at 11h. 36m."

MINOR PLANETS.—The planet (7) Iris is in opposition this month, and as its magnitude is 7·2 it is within reach of binoculars. The following ephemeris for Greenwich midnight is by M. Michkovitch (Marseilles Circ. No. 512), with corrections of +0·4m., +4′, deduced from an Algiers observation on August 16:—

	R.A. h. m.	N. Decl. ° ′	log r	log Δ
Sept. 9	23 29·3	8 44	0·295	9·993
14	23 25·1	8 23		
19	23 20·7	7 57	0·290	9·981
24	23 16·3	7 26		
29	23 12·7	6 52	0·286	9·982

Perihelion passage will be early in 1922.

Astr. Nach. No. 5116 contains the names assigned by Prof. M. Wolf to seventeen planets discovered by him in recent years. Planets 834 and 907 are named respectively Burnhamia and Barnardiana after the two famous American astronomers.

Species in Foraminifera.

ATTENTION should have been directed sooner than now to an interesting paper by Messrs. E. Heron-Allen and E. Earland on the species of *Verneuilina polystropha* and some other Foraminifera (Proc. Roy. Irish Academy, vol. 35, Section B, No. 8, pp. 153–77, 3 pls.). It is in part a contribution to the study of variation in the Foraminifera, and in part an account of certain experiments, which, to say the least, are very suggestive to those interested in the problem of species. Variation in Foraminifera may affect the size of the primordial chamber, the plan or arrangement of the chambers, and the external form. The authors also discuss the occurrence of gigantism and nanism, the predominance of the chitinous membrane over the calcareous shell, and the changes involved in a free or adherent mode of life within the same species. The facts seem to the authors to prove the futility of all classifications of Foraminifera based on the external shell, but the difficulty is to find any other basis.

The normal *Verneuilina polystropha* is a remarkably constant form, singularly free from the variations and monstrosities which occur in normal circumstances among other Foraminifera. It shows dimorphism, represented by a long form which is megalospheric and by a short form which is always microspheric. The megalospheric primordial chamber is sometimes divided into two chambers by an internal chitinous septum. Dwarf or pigmy forms also occur which cannot be confused with young specimens.

Experiments go to show that there is in *V. polystropha* a marked tendency to select and incorporate heavy minerals among the normal siliceous sand grains. A number of the specimens utilised gem-splinters "of a size and shape utterly disproportionate to the size of the tests, thus producing a variety which presents a striking contrast to the normal type." The observation would have had greater value if the number of specimens that "selected" *large and heavy* gem-splinters had been given, so that it might be compared with the number that had simply incorporated gem-sand and with the number of those that kept to ordinary sand. Fifty per cent. of ordinary sand was supplied along with the gem-sand. Another observation records the occurrence of monsters in considerable proportion in a tank with sea-water rendered hypertonic by doubling the normal lime-content.

The paper points to the idea that in a natural system of Foraminifera the processes of construction and habits of growth and reproduction must count as of more value than the material employed in the construction of the test. We hope that the authors will make their proof of the "selection" of shell-material more convincing. It is a very important point.

Biological Statistics.

IN the first article in the current issue of *Biometrika* (vol. 13, parts 2 and 3, July, 1921, Cambridge University Press; 25*s*.) Prof. Karl Pearson and Miss A. G. Davin give us a study of the sesamoids of the knee-joint in man. The best-known works on the subject are those of Gruber and Pfitzner, but, as a whole, the records of these bones are scanty and unsatisfactory, so that an up-to-date attempt to deal with the subject, using the evidence obtained from skiagrams, is welcome. It has been stated fairly freely in the past that sesamoids are manufactured from cartilage by intensive stress, but the authors point out, and adduce evidence in support of the view, that it is more probable that they are vestiges of some structure of earlier form. The available measurements show that there are orthosesamoidal (true bone sesamoid) lateral fabellæ in about 7 per cent. of the knee-joints of man, and few, and possibly no, cases of orthosesamoidal mesial fabellæ. Part of the paper is devoted to an interesting historical note on the subject, including a discussion of the "sesame," from which the name "sesamoid" is derived; it is written in a way that is a pleasant reminder of the spirited manner of some historical studies published by one of the authors a good many years ago.

Miss Tildesley contributes a paper on the Burmese skull, which is a valuable continuation of the large amount of useful measurement and investigation that has already been done at University College, London. The present work is based on 142 skulls procured by the late Col. P. H. Caster from the neighbourhood of Moulmein, and the material is divided according to sex and also into three groups according to race—or supposed race. Miss Tildesley gives a large number of measurements for each skull, and in comparing her results with such measurements as she could find of Chinese, Hindu, etc., skulls, she gives a coefficient, suggested by Pearson, which may be helpful in measuring race-likeness. Whatever view may be taken by craniologists with regard to this index, they will at any rate be grateful for the material collected and published, and approve the way in which Miss Tildesley displays her facts and puts all her cards on the table, so that others have the opportunity of drawing their own conclusions. We may particularly commend as an aid to comparison the loose contours on thin paper. The article contains a useful table for calculating the occipital index, and gives evidence of the agreement of measurements obtained directly from the skulls with those obtained from contours.

"Student" continues his studies of probable errors commenced in earlier issues, and gives, on the basis of extensive sampling, an experimental determination of the probable error of Dr. Spearman's correlation coefficients obtained by replacing actual measurements by ranks. This experimental method seems to us the sound way of getting down to the real distribution of deviations; it affords the right kind of check on any theoretical statistical investigation. The issue also contains a further mathematical article by Prof. Tchouproff, of Petrograd, on "The Mathematical Expectation of the Moments of Frequency Distributions," and one confesses to a feeling of wonder that work of this kind can be produced from Petrograd at the moment. There are also three short notes by Prof. Pearson and a review by Miss Elderton of an American study of women delinquents.

It will be seen that the issue contains papers that should interest different classes of scientific readers, and it may be added that the journal, which is produced by the Cambridge University Press, is well up to the standard which we have grown to expect of that press.

University and Educational Intelligence.

CAMBRIDGE.—Applications for the George Henry Lewes studentship in physiology, shortly to be vacant, should be sent with a brief statement of the candidate's qualifications, the subject of his proposed research, and the name of a referee, to Prof. Langley, the Physiology School, by October 1. The studentship is of the annual value of about 245*l*., tenable for one to three years at the discretion of the trustees.

MR. G. S. MOCKLER has been appointed lecturer in geology in the University of Durham.

PROF. G. W. O. HOWE, of the City and Guilds (Engineering) College, has been appointed superintendent of the electrical department of the National Physical Laboratory.

THE degree of Doctor of Law has been conferred on Sir William J. Pope by McGill University on the occasion of the annual meeting of the Society of Chemical Industry held in Montreal.

MR. P. VAN DER BIJL, formerly of the Natal Herbarium, has been appointed professor of phytopathology and mycology in the University of Stellenbosch, Union of South Africa.

MR. J. BARR, head of the textile analysis department of the City of Bradford Conditioning House, has been appointed manager of the new yarn-testing bureau at University College, Nottingham.

A COMPETITION for vacancies in the grade of chemists, Class II., in the department of the Government Chemist will shortly be held. In this connection a leaflet of regulations governing the appointments has just been issued. It is obtainable until September 15 from the Government Chemist, Clement's Inn Passage, W.C.2.

A SYLLABUS of the courses which will be available at the Sir John Cass Technical Institute, Jewry Street, London, E.C., during the session 1921–22 has been issued. Systematic courses in experimental science preparing students for the science examinations of London University and the Institutes of Physics and Chemistry will be given, but the trend of instruction generally is in the direction of technology, particularly of the chemical, metallurgical, and electrical industries. Full facilities are provided in all departments for research work. Higher technological instruction is provided for by special courses on the fermentation industries, glass technology, colloids, metallography and pyrometry, heat treatment and the mechanical testing of metals, and petroleum technology. The latter constitutes a new development which has been helped forward largely by the generosity of the leading oil companies; a two years' course has been arranged which is designed to meet the needs of those associated with practical and scientific control in the petroleum industry.

THE issues of the *British Medical Journal* of September 3 and the *Lancet* of August 27 constitute the educational and student's numbers which our two contemporaries publish annually at this time. In both will be found full and up-to-date information of the facilities for medical training in the British Isles, as well as the regulations for the various diplomas and degrees which can be obtained. Useful articles are also included which deal with public health and medical services, and with the medical services in the Army, Navy, Air Force, and in the Colonies. Some interesting figures are given in the *British Medical Journal*, showing the annual entry of first-year students in the British Isles during the past twenty years. Before the war the average number was 1400, while during the war it increased to 1900. In May, 1916, the total number of students in training was 6103; two years later it was 7630, and in January, 1919, the numbers rose to 9490. Under the influence of demobilisation in 1919, 3420 new students were registered; and although in 1920 the number had dropped to 2531, there appears to be grave apprehension that the demand for medical men in the near future will be much below the numbers already in training.

Calendar of Scientific Pioneers.

September 8, 1894. Hermann Ludwig Ferdinand von Helmholtz died.—The son of a Potsdam professor of literature, Helmholtz served as a surgeon in the Prussian Army, was a professor of physiology at Königsberg, Bonn, and Heidelberg, in 1871 became professor of physics at Berlin, and in 1887 was made director of the Physikalisch-Technischen u. Reichsanstalt at Charlottenburg. Accounted one of the world's greatest men of science, he was one of the first to grasp and advocate the principle of the conservation of energy, invented the ophthalmoscope, contributed specially to physiological optics and acoustics, discovered the fundamental properties of vortex motion in fluids, and made advances in many branches of mathematical physics.

September 9, 1841. Augustin Pyramus de Candolle died.—Born in Geneva in 1778, de Candolle first lectured on botany at the Collège de France in 1804. A great advocate of the natural system of classification, his "Flore Française" appeared in 1805. From 1806 to 1812 he investigated the botany and agriculture of France and Italy for Napoleon.

September 9, 1896. Luigi Palmieri died.—The successor of Melloni as director of the observatory on Vesuvius, Palmieri for many years held chairs in the University of Naples, and was known for his study of atmospheric electricity and seismology.

September 11, 1768. Joseph Nicolas Delisle died.—An ardent astronomer, Delisle from 1726 to 1747 was attached to the newly founded Imperial Academy of Sciences at St. Petersburg, where Euler and Daniel Bernoulli were his colleagues. After his return to France he became Geographical Astronomer to the French Navy.

September 11, 1913. Sir Walter Noel Hartley died.—From 1879 to 1911 Hartley was professor of chemistry at the Royal College of Science, Dublin. He was among the pioneers in the application of spectroscopic methods to the study of the elements, and was the first to prove the presence of gallium in the sun. He also made researches in the Bessemer process of making steel.

September 12, 1888. Richard Anthony Proctor died.—A prolific writer and a gifted lecturer, Proctor not only did much to popularise astronomy, but also made researches on the rotation period of Mars and on other subjects. The periodical *Knowledge* was founded by him in 1881.

September 13, 1877. Johann Jakob Nöggerath died.—On the founding of the Bonn University in 1818, Nöggerath was appointed to the chair of mineralogy. Among his work was an extensive study of the minerals and geology of Rhenish Westphalia.

September 14, 1712. Giovanni Domenico Cassini died.—The founder of the famous family of astronomers, Cassini was invited to France in 1669, and from 1671 until the Revolution the Paris Observatory was the home of himself or one of his descendants. Between 1665 and 1675 Cassini determined the period of rotation of Jupiter and Mars, discovered four satellites of Saturn and observed the double ring of that planet, and made the first successful estimate of the sun's distance. He afterwards determined the period of rotation of the sun and the oblateness of Jupiter, and made a chart of the moon.

September 14, 1879. Bernhard von Cotta died.—The friend of Lyell, von Buch, and Humboldt, Cotta from 1842 to 1874 was a professor at the Mining Academy at Freiburg, Saxony. One of the first to apply the microscope to the study of fossil plants, he travelled extensively, wrote on the geology of the Alps and on mountains, and did much to popularise the study of geology. E. C. S.

Societies and Academies.

CAPE TOWN.

Royal Society of South Africa, August 17.—Dr. J. D. F. Gilchrist, president, in the chair.—L. **Péringuey**: Note on the occurrence of native-made bronze and brass objects in South Africa.—H. G. **Denham**: Note on the sub-salts of bismuth.

HOBART.

Royal Society of Tasmania, June.—Mr. L. Rodway, vice-president, in the chair.—W. L. **May**: New species of fossil Mollusca. A number of specimens collected by Atkinson from the fossil cliffs at Wynyard.—H. H. **Scott** and C. **Lord**: Studies in Tasmanian mammals, *Zaglossus Harrissoni*, sp.nov. A new species of giant anteater, estimated to be some 660 mm. in length, and more robust in proportion than the largest Tasmanian Tachyglossus of to-day. The type-locality is the Pleistocene deposits of King Island, Bass Straits.

July.—Mr. L. Rodway, vice-president, in the chair.—E. **Ashby**: Description of new species of Loricella.—A. N. **Lewis**: The Glacial remains in the National Park of Tasmania.—G. H. **Hardy**: Australian Bombyliidæ (Diptera).

Books Received.

Jahrbuch des Norwegischen Meteorologischen Instituts für 1920. Pp. xiv+174. (Kristiania.)

The Alo Man: Stories from the Congo. By Mara L. Pratt-Chadwick and L. Lamprey. (Children of the World.) Pp. 170. (London and Sydney: G. G. Harrap and Co., Ltd.) 3*s.* 6*d.* net.

Studies in Deficiency Disease. By Dr. Robert McCarrison. (Oxford Medical Publications.) Pp. xvi+270. (London: H. Frowde and Hodder and Stoughton.) 30*s.* net.

Das Klima Thrakiens als Grundlage der Wirtschaft. By Prof. Erich Obst. (Osteuropa Instituts in Breslau: Vorträge und Aufsätze. iv Abt., Geographie und Landeskunde. Heft i.) Pp. 61. (Leipzig and Berlin: B. G. Teubner.) 2*s.* 6*d.*

What is Science? By Dr. Norman Campbell. Pp. ix+186. (London: Methuen and Co., Ltd.) 5*s.* net.

Turbines. By A. E. Tompkins. Third edition, entirely revised. Pp. viii+180. (London: S.P.C.K.; New York: The Macmillan Co.) 8*s.* net.

British Insect Life: A Popular Introduction to Entomology. By E. Step. Pp. 264+32 plates. (London: T. Werner Laurie, Ltd.) 10*s.* 6*d.* net.

The Trend of the Race: A Study of Present Tendencies in the Biological Development of Civilized Mankind. By Prof. S. J. Holmes. Pp. v+396. (New York: Harcourt, Brace and Co.) 4 dollars net.

The Land and its Problems. By C. Turnor. (A New Series on Economics.) Pp. 254. (London: Methuen and Co., Ltd.) 7*s.* 6*d.* net.

Animal Life of the British Isles: A Pocket Guide to the Mammals, Reptiles, and Batrachians of Wayside and Woodland. By E. Step. (The Wayside and Woodland Series.) Pp. vii+184+111 plates. (London and New York: F. Warne and Co., Ltd.) 10*s.* 6*d.* net.

Origin and Evolution of the Human Race. By Dr. A. Churchward. Pp. xv+511+78 plates. (London: G. Allen and Unwin, Ltd.) 45*s.* net.

Ministry of Munitions and Department of Scientific and Industrial Research. Technical Records of Explosives Supply, 1915–1918, No. 2. Manufacture of Trinitrotoluene (TNT) and its Intermediate Products. Pp. viii+116. (London: H.M. Stationery Office.) 17*s.* 6*d.* net.

The Book of Nature Stories. By H. W. Seers. (Reprint of "Nature Stories to Tell to Children.") Pp. 256. (London and Sydney: G. G. Harrap and Co., Ltd.) 5*s.* net.

God's Country: The Trail to Happiness. By J. O. Curwood. Pp. 167. (London: Duckworth and Co.) 6*s.* net.

Mining Physics and Chemistry. By J. W. Whitaker. Pp. xii+268. (London: E. Arnold and Co.) 9*s.* net.

The Mechanism of Life in Relation to Modern Physical Theory. By Prof. J. Johnstone. Pp. xii+248. (London: E. Arnold and Co.) 15*s.* net.

Chemical Disinfection and Sterilization. By Dr. S. Rideal and Dr. E. K. Rideal. Pp. vii+313. (London: E. Arnold and Co.) 21*s.* net.

A Manual of Pharmacology. By Prof. W. E. Dixon. Fifth edition, completely revised. Pp. xii+468. (London: E. Arnold and Co.) 18*s.* net.

Western Australia: Geological Survey. Bulletin No. 78. The Mining Geology of Kookynie, Niagara, and Tampa, North Coolgardie Goldfield. By J. T. Jutson. With Petrology, by R. A. Farquharson. Pp. 98+5 plates. (Perth, W.A.)

A Critical Revision of the Genus Eucalyptus. By J. H. Maiden. Vol. 5, part 7. (Part 47 of the complete work.) Pp. iv+187–223+4 plates. (Sydney: W. A. Gullick.) 3*s.* 6*d.*

CONTENTS

	PAGE
The British Association	33
Science in the Middle Ages	34
Plantation Rubber Research. By H. P. S.	35
Aeronautics. By Dr. S. Brodetsky	36
A Text-book on Oceanography. By J. J.	38
Our Bookshelf	39
Letters to the Editor:—	
The Apparatus of Dr. Russ.—Prof. C. V. Boys, F.R.S.	40
The Designation of the Radium Equivalent.—N. Ernest Dorsey	40
Pisidium clessini in British Lochs.—A. W. Stelfox	40
Scientific Publication.—Dr. William B. Brierley	41
Whispering-Gallery Phenomena at St. Paul's Cathedral.—Prof. C. V. Raman and G. A. Sutherland	42
Ceratium furca and *Pedalion mirum*.—Alfred E. Harris	42
Illumination of Plankton.—Lt.-Comdr. G. C. C. Damant	42
Co-operative Indexing of Periodical Literature.—H. W. Wilson; The Writer of the Article	43
The British Association at Edinburgh. By Prof. J. H. Ashworth, F.R.S.	44
Some Aspects and Problems of Post-war Science Pure and Applied. By Sir T. Edward Thorpe, C.B., D.Sc., Sc.D., LL.D., F.R.S.	44
The British Association at Edinburgh:—	
Abstracts of Presidential Addresses	56
The Present Position of the Wave Theory of Light. II. By Dr. R. A. Houstoun	61
Classical and Modern Education. By W. Bateson, F.R.S.	64
Notes	66
Our Astronomical Column:—	
The August Meteoric Display	69
The Bright Object near the Sun	69
Minor Planets	69
Species in Foraminifera	70
Biological Statistics	70
University and Educational Intelligence	70
Calendar of Scientific Pioneers	71
Societies and Academies	72
Books Received	72

THURSDAY, SEPTEMBER 15, 1921.

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Cholera Risks.

RECENT Press telegrams emphasise Poland's struggle to resist the tide of infection of typhus, small-pox, and cholera which is rolling up from Russia, while the *Times* announces that the Mecca pilgrimage has been declared free from cholera, and the work of the International Quarantine Board, shortly to be absorbed into the Public Health Department, is eulogised, and its possibilities of co-operation to protect the world from the Russian cholera danger are stated.

The association of famine, like that of war, with great outbreaks of epidemic disease is well known. The exigencies of both war and famine commonly mean the aggregation and a vastly enhanced movement of masses of people, thus greatly increasing the likelihood of transmission of infection at a time when the possibility of precautionary measures is reduced to a minimum. This general problem is of great interest both historically and in connection with current events.

The terrible ravages of typhus in Russia, Poland, and Serbia during the war and since its formal termination are well known, and its almost complete absence from the ranks of the Western belligerents is striking evidence of possibilities of prevention when there is a background of civilian behind the military sanitary administration. Small-pox similarly has been kept under control, and sanitary measures and anti-typhoid inoculations have made typhoid fever a shadow of its former self.

Against cholera a country in a most backward condition as regards the elementary sanitation of water supplies and sewerage is almost helpless, and the chaos of practical anarchy adds to its difficulties. It is this conjunction of events which makes Russia a source of danger, not only to Germany and Poland, its immediate neighbours, but also to a less extent to Europe generally, and even to America, so soon as frequent human intercommunications are established.

Assuming that no efficient action is likely to be taken in Russia itself, the possibilities of preventing importation and of obviating the spread of imported infection of cholera vary according to the country concerned. In a country like Poland, recently reconstructed out of several nationalities and with hastily improvised organisation, the difficulties are exceptionally great. The history of cholera in Poland this autumn, and still more next summer, will depend chiefly on the extent to which the water supplies of its towns and villages are liable to specific contamination by human choleraic discharges. It is not surprising to learn that in Russian refugee camps mass inoculation against cholera has been begun. This measure is still in its infancy, and the personal immunity thus secured is relatively short. We need not be surprised, therefore, to learn, in the early future, of attempts at land quarantine, which in the past has never succeeded in preventing the importation of infection. This has been shown both in European and American experience; one American hygienist compares attempts at inland quarantine to *delirium ferox* in the scale of insanity. Such quarantine has always been incoherent, uncertain in administration, a source of friction and interference with trade, without commensurate sanitary gain. It is important, of course, to supervise the medical condition of immigrants from infected localities and to keep them under surveillance if their condition is suspicious, but to take similar action for large masses of population or for a prolonged period is foredoomed to failure.

Similar remarks apply partially to efforts of maritime quarantine. When rigidly enforced it has embarrassed commerce, and has not succeeded. Even in the case of immigrants arriving in American ports from Europe, the failures to prevent the importation of cholera by rigid quarantine at the port of arrival have been conspicuous. In infected neighbourhoods in Manila 6 to 7 per cent. of healthy individuals were found to be "carriers" of cholera bacilli in their intestinal contents, and when we note that these bacilli may

be harboured for as long as sixty-nine days it is easy to understand how quarantines may be passed and apparently inexplicable outbreaks may occur.

The question arises as to whether in practical administration it is possible to examine the rectal contents of all immigrants before allowing them to proceed to their destination. This has been done partially both in Egyptian and in American administration, and on a small scale this application of Koch's discovery in 1883 of the comma-bacillus of cholera is practicable. On a large scale it fails, for reasons which need not be amplified here.

In actual fact the wisdom of the English system of trusting to medical inspection and detention of actual patients and suspected patients at the port of entry, and of trusting still more to the local sanitary machinery in each division of the country, has been justified by long experience. Quarantine is an elaborate system of leakiness, as has been shown by the experience of all invaded countries. In 1831 every country in Europe was invaded by cholera despite all efforts to keep it out. In 1849, 1853, and 1865–66 this experience was repeated in England, though on these occasions no attempt hermetically to seal the ports was made.

It took Simon and his colleagues in the Privy Council, the Board of Health, and the Local Government Board, the successive central health authorities of England, twenty-five years to make any impression on other countries in favour of the abolition of the futile and oppressive measures of quarantine, and the substitution of medical inspection for detention, followed by local supervision; but these principles have now become generally adopted in settled countries with adequate sanitary administration, and it has become recognised that trust in quarantine gives a false security, and, furthermore, delays the adoption of the internal measures of general sanitary administration both as to *personnel* and water supplies, on which reliance must chiefly be placed.

There need be no fear of a serious outbreak of cholera in this country, even if occasional cases of the disease evade the meshes of medical inspection and supervision. Such exceptional cases might by personal infection or by infecting articles of food even produce small local outbreaks; but this is unlikely, and if it should occur public health administration in every part of this country is equal to the task of suppressing an outbreak, whether of cholera, or typhus, or small-pox.

The Human Factor.

An Introduction to the Psychological Problems of Industry. By F. Watts. Pp. 240. (London: George Allen and Unwin, Ltd., 1921.) 12*s.* 6*d.* net.

THE fact that our industrial system has a human, as well as a material, side has been brought prominently into view in recent times, and it is beginning to be recognised clearly that no perfect or satisfactory industrial system can be attained along the road of purely material progress. Hence industrialists all over the world who have hitherto had their eyes turned wholly on physical science as the main source from which contributions to industrial progress were to be expected are now turning their eyes towards the sister science of psychology so long neglected and misunderstood. Fortunately, the latter science has, within the last generation, been developed in a direction and to a point which make it possible for the psychologist to meet—at least partially—the claims thus coming upon him from a new quarter. Psychology, no longer the science which confines its study to mental process in the individual mind, but the science which studies the behaviour of all living organisms, is now fully conscious of its practical significance and of its duty to the worker in every sphere of activity.

This changed outlook, both in industry and in psychology, is exemplified by the work of the scientific-management engineers, on the one hand, and the number of recent books on industrial psychology written by professed psychologists on the other. Münsterberg, Swift, Hollingworth, Myers, Muscio, and others have already produced a fairly extensive literature in this new field. The latest book of this kind, and one of the most interesting and suggestive, is Mr. Frank Watts's "Introduction to the Psychological Problems of Industry." While generally similar to the other existing books on the same subject, Mr. Watts's work has also certain important characteristics of its own which are worthy of something more than mere passing notice.

The chapter headings indicate the line of thought pursued—"The Psychological Point of View in Industry," "Industrial Fatigue and Inefficiency," "Vocational Selection," "Industrial Unrest," and so on. It will be noted that the author by no means confines himself to the various problems of the factory which can be experimentally studied by the methods of the experimental laboratory. In fact this, the chief part of most other works on the same subject, is a

relatively minor part of the book before us. Vocational selection, for example, is treated very briefly and, on the whole, rather slightingly. This is really the only serious blemish on a valuable piece of work, a blemish which is scarcely removed by a promise in a footnote to deal with the subject of vocational selection in another book to be published shortly. This defect is, however, in our opinion, compensated by the very interesting discussion from a psychological point of view of some of the larger and more pressing problems of labour, beginning with chap. v. on "Scientific Management and Labour," and continued in chap. vi. on "Industrial Unrest," the most important chapter in the book.

Mr. Watts has made a serious and, on the whole, very successful attempt to apply the newer psychology of human tendencies and emotions—the psychology of McDougall, Trotter, Freud, and Jung—to the conditions and problems of industrial life. The attempt is all the more deserving of attention because it is the most elaborate attempt that has hitherto been made, in this country at least, though Myers, Muscio, and Tead have all made pioneer journeys into this field. The use made of the Freudian psychology to interpret the phenomena of social unrest is particularly noticeable. The analogy between the individual and society is a very old one, but this is the first attempt we have come across to work out the analogy in any detail in the sphere of psychopathology. It need scarcely be said that due caution must be exercised in such an undertaking, and that the analogy easily breaks down if it is pressed. Nevertheless, Mr. Watts must be congratulated on the skilful manner in which he has carried out a difficult task, and the very important and suggestive results to which he has been led.

Early in the book the author points out that there has been, and is still, a good deal of scepticism about the practical possibilities of psychology, more especially, perhaps, in the sphere of industry. In his opinion this scepticism is due largely to the fact that the psychologist has been "too frequently unwilling to quit the enclosures of a narrow specialism, and adventure into the fields of public controversy, there to pass judgment in his own way on current tendencies in art, religion, industry, and politics." This aloofness from the concerns of practical life can no longer be charged against the psychologist. All kinds of significant developments are taking place at the present time in every direction of practical activity, pointing to a growing appreciation of the practical significance of psychology; but surely the charge against the psychologist is an error. The psychologists of an earlier day, in this as in other countries, have been as ready to express their opinions on the questions of the day as have the representatives of the physical sciences. The real reason for the scepticism is that the older psychology was not capable of throwing any very clear or definite light on practical problems, and practical men are only now beginning to be convinced that the newer psychology is in a somewhat different position. Books like that of Mr. Watts's will give a strong stimulus to the spread of this conviction. From this point of view it is of quite exceptional interest and importance.

J. D.

History of Science in Edinburgh.

Edinburgh's Place in Scientific Progress. Prepared for the Edinburgh Meeting of the British Association by the Local Editorial Committee. Pp. xvi+263. (Edinburgh and London: W. and R. Chambers, Ltd., 1921.) 6s. net.

THE British Association handbook which has been prepared by the Local Editorial Committee differs entirely in scope from what has usually been offered to the members of the Association. With the present high cost of printing it was early decided that it was practically impossible to give anything like a satisfactory presentation of the city as regards its history, its public services, its educational, industrial, and commercial life, and its general plan and architecture, as well as the customary details of the botany, natural history, and geology of the surrounding region. Such a glorified guide-book seemed scarcely called for in a city like Edinburgh, about which so much literature already exists. There is, however, one aspect of Edinburgh life which, as a whole, has been neglected in the many books which have been written concerning the capital of Scotland, and this is the aspect which should appeal especially to members of an Association the aim of which is the advancement of science. It is briefly expressed by the title, "Edinburgh's Place in Scientific Progress."

In this small volume of 263 pages we find a comprehensive epitome of what has been done by Edinburgh men and men trained in Edinburgh schools towards the advancement of science in all its recognised branches. No fewer than twenty-five authors have contributed to the work, each dealing with his or her appropriate section. Of these the majority are connected with the university, either as graduates or members of the teaching staff. A brief glance at the contents will suffice to show the nature of the book.

Section 1, on mathematics and natural philosophy, is by Dr. C. G. Knott, with subsections on astronomy by Prof. Sampson, actuarial science by Dr. A. E. Sprague, and meteorology by Mr. Andrew Watt. Here we find chronicled the important advances made by Napier, Gregory, Stirling, and Maclaurin in mathematics; by Leslie, Forbes, Balfour Stewart, Waterston, Tait, and Maxwell in experimental and mathematical physics; by Buchan in meteorology; by Dr. T. B. Sprague in actuarial science; and by Henderson in astronomy. In section 2 Dr. Dobbin treats of pure chemistry; Principal Laurie of industrial chemistry; and Mr. Steuart of the shale oil industry. Black, Rutherford, and Hope receive particular notice; the share the industrial chemists of Edinburgh took, and still take, in the production of certain important drugs is duly chronicled, and also the remarkable work of James Young in initiating the manufacture of paraffin. Section 3 is devoted to geology, and Messrs. E. B. Bailey and D. Tait, of the Scottish Geological Survey, tell the story of the pioneer work of Hutton, and bring down the record of the work done by Hugh Millar, Maclaren, Traquair, and the Geikies to quite recent days, when botanists and geologists mutually rejoice in the revelations of the fossils of the Rhynie chert.

In section 4, on engineering, Prof. Hudson Beare recounts Symington's early attempts to propel ships with steam power; tells of Nasmyth, of steam-hammer fame; and shows forth the labours of Robert Stevenson and his descendants in designing and building lighthouses and improving lighthouse illumination.

Section 5, zoology, is from the pen of Dr. James Ritchie, who brings out (what is further established by the later articles on botany, geography, and medicine) how greatly the study of natural history was fostered by the teachers and students in Edinburgh's medical schools. The most conspicuous names among these are Edward Forbes, Allman, Wyville Thomson, and Charles Darwin, who spent two years studying natural science at Edinburgh. Although largely a branch of zoology, oceanography is treated as a separate section, and in it Prof. Herdman (himself an Edinburgh graduate) traces the succession of oceanographical developments in Edinburgh through the life labours of Edward Forbes, Wyville Thomson, and John Murray, bringing the story down to W. S. Bruce's *Scotia* expedition and Murray's last voyage in the *Michael Sars*. Section 7, botany, is by Mr. W. W. Smith, of the Royal Botanic Gardens. It is interesting to note that the first chair of medicine in the university was the chair of botany and medicine, and that the founding of this chair followed the institution of the "Medicine Garden," which ultimately developed into the Royal Botanic Garden. Of the many mentioned in connection with Edinburgh, the most conspicuous are Hope, Arnott, Hooker, Graham, Balfour, Robert Brown, and Dickson. A brief subsection on forestry, by Sir John Stirling-Maxwell, emphasises the strong lead taken by Edinburgh in the promotion of forestry as a science.

In section 8, on agriculture, Mr. J. A. S. Watson records the invention of the threshing machine by Meikle, of East Lothian, and the important work done by Shireff in the improvement of cereals. The Edinburgh chair of agriculture, founded in 1790, seems to have been the earliest in any country. Mr. G. G. Chisholm, in the article, "Geography," section 9, begins by giving an impressive list of travellers and explorers who, born or trained in Edinburgh, have notably extended geographical knowledge. A brief history is also given of the two well-known cartographical firms which have brought fame to the city. Section 10 deals with anthropology under the two headings of "Archæology," by Mr. J. H. Cunningham, of the Society of Antiquaries of Scotland, and "Physical Anthropology," by Prof. Robinson. The systematic excavation of ancient sites is now the great feature of archæological research, and the very recent discoveries at Traprain Law have excited great interest. On the other hand, the remarkable collection of skulls and skeletons now in possession of the university anatomical department has been only partially discussed by Turner, Cunningham, and others.

Section 11, on medicine and surgery, constitutes the largest of all the sections, and is the work of three authors, Dr. J. D. Comrie and Prof. Ritchie, treating of the Edinburgh Medical School, and Dr. Alexander Miles, who treats of surgery. The chairs of botany, natural history, and chemistry were all originally chairs in the medical faculty of the university, a fact which explains the valuable work done in pure science by leading Edinburgh physicians and others trained in the medical school; and the same keenness was shown down the centuries in the scientific study of anatomy, physiology, *materia medica*, and other branches of medical and surgical knowledge. The university professors and the teachers in the extramural school alike brought renown to their city as a great centre of medical training. Monro *secundus*, Charles Bell, Benjamin Bell, Sharpey, Goodsir, Christison, James Young Simpson, and Lister are a few of the many whose names are

familiar to the student of medicine. In a brief article on dentistry Dr. William Guy pointedly refers to the anatomist Goodsir for his early work on the development of the teeth.

Section 13, on political economy, is contributed by Prof. Nicholson, who leads up through the labours of Adam Smith's predecessors to Adam Smith himself, the great economic genius of all time, and then discusses the work of later economists, such as Macpherson and M'Culloch. Dr. Drever supplies the articles on psychology and education, sections 14 and 15 respectively, in which David Hume, Dugald Stewart, the brothers Combe, Laurie, and Melville Bell find their appropriate places. Finally, in section 16, Miss Nora Milnes describes the social aspects of Sir Robert Philip's anti-tuberculosis dispensary movement and the important part played by Edinburgh authorities in child welfare schemes.

The whole record of scientific work as presented in these contributions to "Edinburgh's Place in Scientific Progress" is one of which any city may well be proud. The work done in Edinburgh and by Edinburgh men does not stand alone, but is closely linked with the labours of men of science in other lands, and it is one of the merits of the book that these international relations are skilfully touched upon by the several writers.

The book is illustrated by portraits of Napier, Black, Hutton, Nasmyth, Edward Forbes, Simpson, Lister, Adam Smith, and David Hume. Intended originally as a handbook for the members of the British Association meeting in Edinburgh, it is being published for general circulation by Messrs. W. and R. Chambers at the price of 6*s*. net.

An Electronic Theory of Valency.

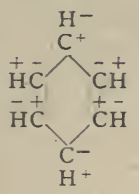
The Electronic Conception of Valence and the Constitution of Benzene. By Prof. H. Shipley Fry. (Monographs on Inorganic and Physical Chemistry.) Pp. xviii + 300. (London: Longmans, Green, and Co., 1921.) 16*s*. net.

PROF. FRY bases his conception of valency on Sir J. J. Thomson's interpretation of the bond (without reference to the nature of chemical affinity or to the structure of the atom) as a unit Faraday tube. Such a bond is produced by the transference of an electron from one atom to another. Furthermore, each atom can both lose and gain electrons, or, in other words, can function as possessing positive and negative valency. Thus a univalent hydrogen atom may function in two ways, as $\overset{+}{H}$ or $\overset{-}{H}$; a bivalent oxygen atom in three ways, $\overset{++}{O}$, $\overset{+-}{O}$, $\overset{--}{O}$; a tervalent atom in four ways; and a quadrivalent atom, such as carbon, in five ways.

On this simple foundation an elaborate system of valency has been built up. It follows from the above assumption that by the combination of two substances X and Y two compounds may be formed—namely, $\overset{+}{X}—\overset{-}{Y}$ and $\overset{-}{X}—\overset{+}{Y}$. These are called electronic isomers, or electromers, and may form an equilibrium mixture. How are they distinguished? The author suggests that if water is composed of $\overset{+}{H}—\overset{-}{O}H$ (though there appears to be no reason why it should not be $\overset{-}{H}—\overset{+}{O}H$) a negative atom or group will attach itself to hydrogen, and a positive atom or group to $\overset{-}{O}H$.

In this way the valency of atoms and groups is determined.

Passing on to part 2 of the work, which deals with aromatic compounds, the electronic formula for benzene is represented as follows:—



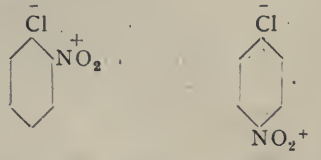
Upon this formula the various reactions of benzene, its physical and chemical properties, as well as those of its homologues and congeners, are based.

It would take up too much space to discuss part 2 in detail, and one or two examples must suffice. It is clear that where substitution takes place a negative atom or group will replace a negative H atom. Here a difficulty appears to arise, for in the case of substitution by chlorine there are two competing atoms in the molecule $\overset{+}{Cl}.\overset{-}{Cl}$. This is met by formulating two electromers, $\overset{-}{C_6H_5}\overset{+}{Cl}$ and $\overset{+}{C_6H_5}\overset{-}{Cl}$. The author assumes that $\overset{-}{Cl}$ enters the nucleus. It follows, then, that $\overset{+}{Cl}$ has to be satisfied with $\overset{-}{H}$, in which case it is to be presumed that the electromer of hydrogen chloride, $\overset{-}{H}\overset{+}{Cl}$, is formed. Similarly with nitric acid, which may exist in equilibrium as

$$\overset{-}{HO}.\overset{+}{NO_2} \rightleftharpoons \overset{+}{HO}.\overset{-}{NO_2}.$$

Here the author gives preference to the first formula, whereby NO_2 replaces electropositive hydrogen in the nucleus. After making these various, though not very convincing, assumptions,

the author proceeds to discuss the action of nitric acid on chlorobenzene, and of chlorine on nitrobenzene. It is well known that in the first case a mixture of ortho- and para-derivatives results, whereas in the second case a meta-compound is formed. As negative chlorine is present in the nucleus, positive NO_2 will naturally replace positive hydrogen, giving



In the second case, where positive NO_2 is already present in the nucleus, and is acted on by $\overset{-}{Cl}.\overset{+}{Cl}$, it is not $\overset{-}{Cl}$ which is now, as it were, received into the family circle, but his brother, $\overset{+}{Cl}$, which therefore enters the meta position. One becomes a little bewildered with the sudden *volte-face* exhibited by the differently charged atoms.

The present writer has no wish to do any injustice to Prof. Fry's theory. There is no doubt that it contains a substantial germ of truth; it explains many facts of substitution, and is sufficiently elastic to undergo almost unlimited extension provided all the postulates are accepted.

J. B. C.

Along the Snow-line of Peru.

The Andes of Southern Peru: Geographical Reconnaissance along the Seventy-third Meridian. By Isaiah Bowman. First English edition. Pp. xi+336. (New York: The American Geographical Society of New York; London: Constable and Co., Ltd., 1920.) 27*s.* 6*d.* net.

THIS pleasantly written, highly interesting, and well-illustrated book by the director of the American Geographical Society is one of the results of the Yale Peruvian Expedition of 1911. Its theme was a reconnaissance of the Andes along the 73rd meridian. The author was responsible for the making of a contour map. The north-to-south journey from the 12th to the 17th degree of south latitude cuts the Andes obliquely across from the tropical rubber-producing plains of the lower Urubamba, north-west of Cuzco, southwards over snow-covered passes to the desert coast of Camaná. For weeks the party laboured across and along bleak, lava-covered country, without interruption, at the uncongenial elevation of between 14,000 and 18,000 ft.

The second part of the present volume deals with the physiography of the Western and Eastern Andes, the coastal terraces, geologic development, and glacial features, with many maps and profiles. Other chapters—*e.g.*, those on climatology and meteorological records—are also necessarily severely technical, but the first part of the book is eminently readable, and instructive from a broad point of view. It is entitled "Human Geography," and the author endeavours to show the effect of environment upon mankind in the widest sense. Witness the chapter entitled "The Geographic Basis of Revolutions and of Human Character in the Peruvian Andes." Many of the points raised may appear obvious, others somewhat far-fetched or laboured, and yet they cause us to ponder, and in not a few instances the author makes good his claim by tracing cultural, political, and other conditions to their respective sources—very obvious when pointed out, but requiring a broad mind, open eyes, and travelled experience.

"It is pleasant to think that the tropical forest may be conquered. It is nonsense to say that man now conquers it in any comprehensive and permanent way. The tropics must be won by the strong hands of the lowlier classes which are ignorant and careless of hygiene. We cannot surround every labourer's cottage with expensive screens, oiled ditches, and well-kept lawns. . . . Travel in the desert is a conflict between heat and aridity, but travel in the tropical forest is a struggle against spaces, heat, and a superabundance of all but useless vegetation."

The regional diagrams introduced are most instructive—*e.g.* Fig. 25:

"When amplified by photographs of real conditions, such a diagram becomes a sort of generalised picture of a large group of geographical facts. . . . It would be a real service to geography to draw up a set of, say, a dozen regional generalised diagrams for a whole continent."

The expedition came across the loftiest habitation in the world. It was crossing at 17,400 ft., and 300 ft. lower was the last outpost of the Indian shepherds, built of stone and thatched, sheltering a family of five, with three fat, rosy-cheeked children. Less than 100 ft. below were other huts, and flocks of alpaca and sheep.

The snow-line is here at the surprisingly high level of between 17,200 and 17,600 ft. Potatoes, small and bitter, but edible, and a variety of maize grow up to 17,400 ft., where they endure repeated frosts. "Perhaps the Indians have arrived at results ahead of those by our professional experimenters."

Our Bookshelf.

The Journal of the Institute of Metals. Vol. 25. No. 1. 1921. Edited by G. Shaw Scott. Pp. xiv+522+27 plates. (London: The Institute of Metals, 1921.) 31*s.* 6*d.* net.

THE papers read before the spring meeting of the Institute and contained in the present volume include two contributions of outstanding importance. One of these, by Mr. Moore and his colleagues, describes observations on the season cracking of brass and other copper alloys. The authors have had an opportunity of dealing with an exceptionally large mass of material, and have come to the conclusion that chemical corrosion plays a prominent part in the initiation of season cracking. Their theoretical explanation assumes the existence of an amorphous film between the crystals.

The second paper is by Prof. Carpenter and Miss Elam, and describes the process of recrystallisation of sheet aluminium on annealing, carrying much further the previous observations of the same authors. They have been able to show that the confused structures which have been described as characteristic of cold-worked aluminium are the result of imperfect polishing and etching, and that well-defined structures may be obtained even in severely strained metal. Dr. Haughton has continued his study of the copper-tin alloys and has defined the limits of the solid solutions at the tin end of the series, obtaining, however, some curious results in the variation of the electrical resistance with temperature.

Prof. Edwards and Mr. Herbert describe experiments on the plastic behaviour of heated copper alloys, employing an impact indentation test. Messrs. Moore and Beckinsale have reinvestigated the action of reducing gases on copper. Mr. P. H. Brace gives a general account of the metallurgy of calcium, about which little is to be found in the literature. The abstracts of metallurgical papers are very numerous and full, so that the volume constitutes an indispensable work of reference on all matters concerning the non-ferrous metals. Mention should be made of the excellence of the illustrations.

C. H. D.

Freshwater Fishes and How to Identify Them. By Dr. S. C. Johnson and W. B. Johnson. Pp. 64. (London: The Epworth Press: J. Alfred Sharp, n.d.) 1*s.* 9*d.* net.

A BOOK that is both cheap and easy to carry in the coat pocket has long been wanted by those who wish to identify our freshwater fishes. This little volume meets their needs. The descriptions are clear and accurate, and are concerned only with external features, while the majority of the illustrations are in themselves sufficient for identification without reference to the letterpress. The authors' style is not always above reproach; nor do we fathom the meaning of "The sturgeon is considered to be a link between true fishes and sharks, as it has gills as fishes have, and a breathing spiracle, as sharks have." Is it that the authors do not regard sharks as "true fishes"; and if not, why not? The usefulness of all books of this type depends largely upon the ease and speed with which the unknown catch can be run to earth and identified; and we have yet to learn that there is anything better for this purpose than a dichotomous "key." We miss any such key in these pages, and would therefore urge the authors to endeavour in any subsequent edition to introduce a "key" which can be applied rapidly in the field. It would also improve the book if dimensions were consistently introduced into the description of each species: we are told that the gudgeon is usually 5 or 6 in. long when full grown; the "record" chub, however, weighed 7 lb. 4 oz., but no hint of length is given; of the barbel we are given neither the weight nor the length—and so on all through. Nevertheless the book will be welcome to many, and may easily be made so to more.

O. H. L.

Agricultural Economics. By Prof. J. E. Boyle. (Lippincott's College Texts: Agriculture.) Pp. ix+448. (Philadelphia, London, Chicago: J. B. Lippincott Co., 1921.) 12*s.* 6*d.* net.

PROF. BOYLE'S book covers a wide field and deals with a subject of increasing importance. It has long been a commonplace that agriculture is a business as well as a science, but only recently have the business principles been clearly enunciated and developed. The book is a useful contribution; the author's position as professor of rural economy at Cornell University brings him in contact with the realities of the subject and saves the work from the danger of becoming commonplace. The author has a good deal to say about the chaos that sometimes seems to reign supreme in agriculture, but we are not sure that it really is as bad as it appears; prior to the war the world's supply was on the whole approximately equal to the demand, and no great "carry-over" was necessary, nor was there a marked deficit. He is on safe ground, however, in insisting on the need for the full co-ordination of production and consumption, and his discussion of the factors concerned in successful business management is both interesting and suggestive.

The Child's Path to Freedom. By Norman MacMunn. A second edition, entirely rewritten, of *A Path to Freedom in the School*, dealing with six further years of educational experiment. Pp. 163. (London: G. Bell and Sons, Ltd., 1921.) 2*s.* 6*d.* net.

THIS stimulating and original book deserves to be studied carefully by every educator, for it illustrates well the value of the application of modern psychology to the problems of mental development. There is much in it which will be actively criticised, but it is well to have educational orthodoxy challenged to defend itself or to modify its procedure, as is done in the pages of this little volume.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Uniform Motion in the Æther.

I SHOULD like to say a few words relative to Dr. Jeffreys's comments on my letter on the above subject in NATURE of August 11, p. 746.

Poincaré asserted that optical phenomena were, in his opinion, rigorously independent of any motion other than the relative motion of the bodies concerned, and this is, I believe, a cardinal tenet of relativity. In my judgment, the case of the moving mirror shows such rigorous independence to be logically impossible, but I do not quite gather whether Dr. Jeffreys accepts or rejects that point of view.

Allowing for the FitzGerald contraction, and also for the aberration, there will be, for an observer on the earth, a general apparent equality of the angles in question only when the motion of the earth is in the plane of the mirror. (I was guilty of a slip here, but so, I think, was Dr. Jeffreys, since, even disregarding the aberration, a motion of the earth normal to the mirror could scarcely allow of the same standard of angular equality for both earth and mirror, the motion of the latter in this case not being normal to its own plane.) Clearly, the existence of such equality determined by and determining one specific direction, is an optical phenomenon which depends on the absolute motion of the earth, not merely on the relative motions of earth and mirror; and if this be admitted it appears to me that the whole structure of relativity falls to the ground, in so far at least as it may not be able to dispense with logic.

As to other points, I believe that if Dr. Jeffreys will consider more closely the manner in which a distortion of the apparatus by the FitzGerald contraction would introduce discrepancies into stellar measurements, he will see that these discrepancies, if discriminable, would reveal, not the relative motion of stars and earth, but the absolute motion of the latter; and a comparison of this with the ordinary estimation of the earth's motion relative to the stars would show whether the whole material universe had a drift in space. Again, I do not find it possible to agree with Dr. Jeffreys that the Michelson-Morley experiment conducted through water would be of little interest. Indeed, it seems to me that this might constitute a crucial test of the whole theory. Supposing Fizeau's law for the light velocity in moving water to be of general application, I believe I am correct in saying that the change of length that must be suffered by the apparatus in the direction of the earth's motion, if the result of the experiment in water moving with the earth is to be negative, should be in the proportion

$$1 : 1 - \tfrac{1}{2}\frac{u^2v^2}{c^4}$$

instead of

$$1 : 1 - \tfrac{1}{2}\frac{u^2}{c^2},$$

as in the FitzGerald contraction, v being the velocity of light in water at rest in the æther and u being small. This would represent only about one-half of the latter contraction, and the test should therefore be decisive under the suppositions made. It is true that I have not allowed for the effect of the FitzGerald contraction upon Fizeau's law, but I do not know that there is general agreement as to the method of estimating this effect, and it seems very improbable that the result would be a complete elimination of v from the expression giving the contraction.

E. H. SYNGE.

Dublin, August 15.

IF we refer several events to the same system of position and time co-ordinates, and then consider the same events referred to another system, the position co-ordinates and times in the two systems are connected by a set of algebraic relations, called the Lorentz-Einstein transformation. The FitzGerald contraction refers only to a part of these relations between the co-ordinates; an argument that assumes it and omits to consider the other relations is not dealing with the principle of relativity. If the positions and times in two systems of reference B and C are connected with those in another system A by such transformations, those in system C can be found in terms of those referred to B by algebra, and it is found that the relation between B and C is another Lorentz-Einstein transformation, and involves no mention of A whatever.

In Mr. Synge's problem of the mirror, we may call the "æther" system A, the earth system B, and the mirror system C. Even if there was a fundamental æther, his suggested experiment deals only with the relations between B and C, and, in consequence of the above theorem, can therefore be treated in terms of their relative motion alone. The "absolute" motion never enters into the question. It would enter, of course, if we tried to tackle the problem by referring everything to system A, but it would be found that the absolute motion eliminated itself when the angles of incidence and refraction were compared. Aberration does not affect the problem, for it increases or reduces both angles equally.

I see no reason to alter anything in my previous note. It is perfectly true that the theory of relativity makes certain positive predictions, and would have to be modified seriously if any of these were proved false by experiment. But it is not true that it predicts anything that involves the absolute motion of the earth in space. Nothing but experiment could refute it; its self-consistency is perfect.

HAROLD JEFFREYS.

Relation of the Hydrogen-ion Concentration of the Soil to Plant Distribution.

IN a series of papers from 1916 onwards Wherry has studied the relation between soil reaction and plant distribution in the United States. He made use of colour tests with indicators for determining the hydrogen-ion concentration of the solution obtained by agitating soil taken near the plant with water. In this manner he showed that the distribution of a species may be limited in a very definite way by the soil reaction, in expressing which it is convenient to record the results in terms of the logarithm of the reciprocal of the hydrogen-ion concentration in grams per litre. This is denoted by the symbol pH, neutrality is at pH7, centi-normal hydrochloric acid is at pH2, and sea-water at about pH8.

Wherry has given the limits for a number of American plants, and shown the soil reaction to be expected in various types of soil. A paper dealing with the subject has also appeared recently in Sweden, giving results obtained by O. Arrhenius, but this is not accessible here as yet.

During the last year determinations of the pH values of soils have been carried out by the writer in India and the British Isles with the view of extending our knowledge of plant distribution. It has been

found that Java indigo can tolerate wide changes in reaction, growing in Bihar in soil at *p*H8·7 and in Assam at *p*H5·4. It, however, does much better in the latter for various reasons.

In the British Isles it has been found that the yellow stonecrop, *Sedum acre*, flourishes in soil from *p*H7 to 8 or over, whereas the white *S. anglicum* may be growing at from *p*H6·8 to 5·1, possibly slightly outside these limits. Plants which are by some regarded as typical species of limestone districts may be found elsewhere provided the soil reaction is suitable; thus *Salvia verbenaca* grows between *p*H7 and 8, *Crithmum maritimum* around *p*H8, and *Cochlearia danica* from *p*H7·5 to 8, possibly over it, much the same range being occupied by *Linaria cymbalaria*; for *Centranthus ruber* values from *p*H7·4 to 8·8 have been obtained. The common gorse, *Ulex europaeus* is usually found on acid soil; in seven cases where it was observed growing in abundance the reaction was *p*H6·8 to 5·4, but one plant was found at *p*H8·1, one at 8·2, and three or four at 8·6. In other cases the soil was probably alkaline, but was not tested.

The sea pink, *Armeria maritima*, may be found between *p*H6·8 and 8·2, but the typical sand-dune plants, *Ammophila arenaria, Euphorbia Paralias, Salsola Kali*, are found only in the neighbourhood of *p*H8.

Moorland plants, *Erica tetralix, Anagallis tenella, Drosera rotundifolia, Jasione montana*, etc., are commonly found at *p*H5·5 to 5, or thereabout, but the limits are certainly wider.

The accumulation of data of this type is of necessity a slow process, but one cannot fail to be impressed by the fact that the presence or absence of a plant in a given locality stands in close relation to the hydrogen-ion concentration of the soil. Plants may survive, or even do well, in cultivation outside their normal limits, but in free competition with their neighbours the soil reaction is often the deciding factor—always, in fact, if the divergence from the normal *p*H value for the species is sufficiently great.

Considerable changes in the soil reaction may be met with in quite a short distance. Thus on crossing a road at Youghal, Co. Cork, one passes from a soil of about *p*H7·5, with *Salvia verbenaca* and *Ononis arvensis*, to an acid soil, *p*H6·8 to 6·4, with gorse, and in the wet parts *Iris pseudacorus* and bog-cotton. This, in turn, passes into sandy pasture and sand dune, the latter giving about *p*H8. Again, near Cawsand, in Cornwall, gorse is plentiful on the felsite soil at *p*H6·4 to 5·4, but absent from the adjacent, and similarly situated, soil of the Staddon Grits, which normally gives *p*H7 to 7·8.

It appears as if corresponding differences are shown by water-plants and fresh-water algæ, the upland waters which are very slightly acid or almost neutral favouring the desmids. There is much room for further work along these lines.

W. R. G. ATKINS.

August 30.

"Smoky" Quartz.

THE deeply tinted varieties of quartz, such as "smoky" quartz and the yellow or Madagascar variety, are generally transparent in the infra-red region of the spectrum to the same extent as clear rock-crystal, as may easily be demonstrated with the aid of a thermopile and galvanometer. I wish to suggest that a very simple physical explanation of this property may be offered. As has been emphasised in a paper by Prof. R. J. Strutt (now Lord Rayleigh) in the Proceedings of the Royal Society for 1919, these varieties of quartz are really optically turbid media, the opacity arising from the scattering of the radiations in their passage through the crystal by a cloud of small particles present as inclusions. Since scattering of this kind is effective in inverse proportion to the fourth power of the wave-length, it can easily be seen why the longer heat-waves can traverse the crystal without appreciable loss. Some photometric observations which I have made of the relative transparency of the yellow and colourless varieties in different parts of the spectrum support this explanation.

In the paper just quoted Rayleigh has described the very beautiful and striking effects that arise owing to optical rotatory dispersion when a strong beam of *polarised* light is sent through a block of smoky or yellow quartz in the direction of the optic axis; the track of the beam, as made visible by the scattering particles and observed in a transverse direction, shows bright and dark bands if monochromatic light be used, and alternations of colour if the incident beam is of white light, the effect being due to the fact that the scattering particles themselves act as *analysers* of the light incident on them. I find that the phenomenon discovered by Lord Rayleigh can be very prettily shown in another way which is also instructive. A thin, flat sheet of *unpolarised* white light may be sent through the crystal in a direction *transverse* to the optic axis, and the track of the beam observed in a direction parallel to the optic axis through a Nicol. In this case the scattering particles act as *polarisers*, and the scattered light suffers a rotatory dispersion of its plane of polarisation in traversing the quartz along the optic axis before reaching the observer's eye. Hence the whole track of the beam as seen through the observing Nicol appears coloured, the tint fluctuating periodically with the thickness traversed as the block is moved to and fro in the line of sight or when the analysing Nicol is rotated.

Rayleigh has shown in his paper that the track of a beam of light traversing a beam of *transparent* colourless quartz can be successfully photographed. I find that by using a concentrated beam of sunlight it is possible *visually* to detect the Tyndall blue cone even in this case. Its intensity, however, is exceedingly small.

C. V. RAMAN.

22 Oxford Road, Putney, S.W.15,
September 4.

Brown Bast and the Rubber Plant.

IN NATURE of June 16 (p. 499), in a paragraph which announces the discovery by the Botany Department of the Imperial College of Science and Technology that "'brown bast' (the most serious disease of *Hevea brasiliensis*) is essentially a question of phloem necrosis," it is stated that Sanderson and Sutcliffe have shown that "burrs result from the inclusion of areas of diseased laticiferous tissue in stone-cell 'pockets' formed by the activities of wound cambiums."

It should be pointed out that the presence of latex vessels in the core of nodules (burrs) was first recorded by Bateson (Agric. Bulletin Fed. Malay States, August, 1913, p. 24), and later corroborated by Richards and Sutcliffe ("*Hevea brasiliensis*," 1914, Malay Peninsula Agric. Assoc.), and by myself (Bulletin 28, Dept. of Agric., Ceylon, October, 1916, and Annals Roy. Bot. Gdn., Peradeniya, vol. 6, p. 257, 1917).

Workers in Java have further confirmed this inclusion of laticiferous tissue as regards the nodules which follow brown bast, and the fact that nodules in the most general case result from the inclusion of areas of diseased laticiferous tissue has been common knowledge in the East for the last five years. That the formation of nodules after brown bast is a secondary

symptom has also been generally recognised. Nodule-formation, however, occurs in many cases other than those in which it is merely a secondary symptom of brown bast.

The occurrence of diseased sieve-tubes in brown bast tissue, prior to the appearance of the disease in or adjacent to the latex vessels, has not been previously recorded, and if this is corroborated it may lead to further advance in our knowledge of this disease.

The statement that the diseased laticiferous tissue is enclosed in "stone-cell pockets" formed by the activities of wound cambiums is at variance with the results obtained by workers in the East generally. Occasionally stone-cell groups, which are abundant in normal cortex, are fortuitously enclosed within the nodule cambium at the time of its inception. The nodule cambium by its subsequent division lays down wood elements on the inside and cortical elements on the outside. It is a striking characteristic of cortex overlying old nodules, and presumably entirely derived from the nodule cambium, that stone-cells are completely absent.

G. BRYCE,
Asst. Botanist and Mycologist.
Department of Agriculture, Peradeniya, Ceylon,
July 21.

MR. BRYCE is quite correct in his reference to the work of Bateson and others. In a brief note, however, historical reference to the bibliography of "brown bast" and related phenomena was not contemplated for a moment. The work of Sanderson and Sutcliffe was mentioned in consequence of the recent publication of their book on "Brown Bast." With the Editor's permission, it is proposed to deal further with the subject of this disease in a future issue of NATURE.

THE WRITER OF THE NOTE.

The Nature of Vowel Sounds.

IF you will permit me to refer at this late date to Prof. Scripture's articles in NATURE of January 13 and 20 last on the nature of vowel sounds, I should like to emphasise the great service that the writer has done in pointing out that the ordinary methods of harmonic analysis are not necessarily adequate for the determination of the composition of a given tone, and may, indeed, give quite a false representation of the facts, because the sound may have inharmonic components. At the same time, it is doubtful whether his note in NATURE of March 3 (p. 12) in reply to another correspondent, interpreting some of Prof. Miller's results in this field, are justifiable. Prof. Miller's curves are evidently harmonic, from the fact that they repeat themselves very faithfully at regular intervals and establish without much doubt that vowel sounds (and some others) at least *can be* so produced that they are susceptible of harmonic analysis, whether they are always of such nature or not. The fact that Prof. Scripture finds the quality of the voice constantly changing in speech is not a matter of surprise, any more than that the human face and form rarely remain exactly the same for two seconds at a time in waking hours; it need not preclude us, however, from seeking to maintain a given quality for a time for purposes of analysis and record, any more than the latter fact prevents us from sitting for portraits.

There is, however, a point in the first article that is open to distinct criticism. The author says (p. 633):—"In the analyses of vowel waves the fundamental is indicated as weak, or often almost lacking. . . . We all know that this is the strongest tone of all." It takes all the point out of scientific research if we are going to discard its plain results for what "we all know," especially if the fact of "knowledge" stands on such weak grounds as does the one here referred to. All that we are justified in saying is that a complex note is by common judgment considered as having the pitch of its fundamental; this may happen in cases in which the fundamental is known to be weaker than the upper partial or partials—a fact for which we have the authority of Ohm, Helmholtz, and the late Lord Rayleigh ("Theory of Sound," vol. 1, sec. 26). When Prof. Scripture states that fundamentals are "not of the nature of sine vibrations," he deprives us of any rational definition of the term; we could build up his type of fundamental vibration from a number of sine vibrations of shorter period, and thus produce a sound of low pitch from a number of high-pitched ones.

What I believe to be the true interpretation of Prof. Scripture's results and those of others in this field—in fact, the inescapable conclusion—is that the fundamental is, indeed, extremely weak in many of the tones produced by the voice and other musical instruments, and that it is further masked in the records by the comparative lack of sensitiveness of the ordinary recording apparatus in the lower ranges. We must then also conclude that there is something in the physiology or psychology of hearing, or in both combined, whereby the lowest component of a complex tone, the fundamental, fixes for the hearer the pitch of the whole tone, while the presence or absence of certain upper partials and their relative strength determines its quality.

The glottal puff theory is not inconsistent with the harmonic theory. Helmholtz accepted it and stated it very clearly, as seen in the following extract from his "Tonempfindungen" (Ellis's translation, p. 103):—"In order to understand the composition of vowel tones we must, in the first place, bear in mind that the source of their sound lies in the vocal chords, and that when the voice is heard these chords act as membranous tongues, and, like all tongues, produce a series of decidedly discontinuous and sharply separated pulses of air (*Luftstösse*), which, on being represented as a sum of simple vibrations, must consist of a very large number of them, and hence be received by the ear as a very long series of partials belonging to a compound musical tone." There remains to be applied a positive test, which, as Prof. Scripture points out, should not be dependent on the harmonic analysis of curves to determine whether or not Helmholtz was right in concluding that the partials of the voice tones are harmonic.

With reference to another point in the articles, it seems to me to be no more justifiable to say that the difference between the voice of a Caruso and that of a costermonger lies solely in the vocal chords than it would be to say that the tone of a reed instrument depends only on the reed, without reference to the size, shape, material, etc., of the rest of the instrument, *e.g.* that the difference between a bassoon and an oboe is only a difference of reeds.

PRESTON EDWARDS.
Clark University, Worcester, Mass., July 11.

THE first essential point of the interesting communication of Mr. Preston Edwards lies in the question of the weakness of the fundamental in the tone of a vowel. This tone is that of the larynx, or the voice tone. To the ear this is always the predominating tone. We may not be able to distinguish what vowel a singer is producing, but if we can hear him at all we hear the tone he is singing—that is, the tone from his larynx. When a larynx from a freshly killed animal is subjected to a blast of air and the vocal chords are brought together, a strong tone is produced.

Mr. Preston Edwards makes the hypothesis that a weak larynx tone arouses a complex of resonance tones in the vocal cavities, and that these are then heard with a strong lower tone corresponding to the larynx tone. We can sing all the vowels with a single strong larynx tone; that all the varied resonance tones should coincide in producing this single strong larynx tone is quite beyond imagination. It is scarcely necessary to follow this thought out; the fact remains that the larynx tone is by far the strongest tone in the vowel, both physically and for the ear.

A comparison of vowels with tones from reed instruments is inadmissible. The resonating cavities in the latter have hard walls and can force their periods on the reeds, whereas the vocal cavities have soft walls and cannot do so.

Helmholtz's theory of the vowels rests on three assumptions :—(1) The vibrations from the larynx are of the form of a simple sinusoid or of the sum of a harmonic series of simple sinusoids. (2) The vocal cavities act like resonators with hard walls. (3) The larynx tone is maintained at constant pitch. This is the condition exemplified in Helmholtz's vowel apparatus, in which tuning-forks (representing the larynx tone) are maintained electrically in vibration before brass resonators (representing the vocal cavities). Such resonators can respond only to harmonics of the fork tone. If the three suppositions are true, the harmonic theory necessarily follows.

In an interesting apparatus devised by Dr. H. Hartridge a series of weights is hung by threads of different lengths from a bar that can be set in sinusoid vibration. When the bar is started all the pendulums begin to swing, but after a few vibrations all become still except the one that corresponds to a harmonic of the period of the bar. It takes, therefore, several vibrations before the period of the bar is forced on the appropriate pendulum, and the others are forced to become still. Remembering the first fact—that a single movement of the bar starts all the pendulums—let us now drop the third supposition above and conform to the truth that the voice tone is never of a constant pitch for a single instant. In speech it changes so rapidly up and down that two successive vibrations are rarely of the same pitch. Each single vibration must start all the pendulums—that is, all the tones of the resonators—and there is no possibility that the tone of the voice can force itself on the resonators. Even retaining the first two suppositions, we are forced to conclude that any harmonic adjustment of the vocal resonators to the voice tone is impossible, because it takes at least two like periods of the voice tone to force its frequency on a resonator, whereas in actual speech the voice tone does not have two like periods in succession. The Helmholtz theory is thus impossible, because the third supposition is contrary to fact.

Let us now examine the effect of retaining the first and third suppositions while modifying the second to fit the facts. The resonators have soft walls, and any vibration aroused in them will die away rapidly. Even if the laryngeal vibration were of the sinusoid form, the resonance vibration aroused by one positive (or negative) phase would die away before the corresponding phase occurs again. To a simple sinusoid or a tuning-fork tone there is at the best only a weak response. With more complicated sinusoids or sharper tones there may be rapidly repeated overtones that evoke some response. The result is utterly different from the loud responses evoked by forks held in front of resonators with hard walls.

The moment we give up the first assumption and accept the fact that the tone from the larynx consists of a series of sharp blows, and not of continuous vibrations, all possibility of the harmonic hypothesis vanishes. A sharp blow can arouse only the free vibration of the cavity, whether hard or soft. The tones aroused are those of the cavities themselves. Their periods have no relation to the period of the blow, simply because the blow itself has no period. Even in a cavity with hard walls the aroused vibration dies away so quickly that the blow would have to be repeated rapidly in order to catch any of the dying motion.

As explained in my account in NATURE (January 13 and 20, pp. 632 and 664), every one of the three assumptions is contrary to fact. If Helmholtz had had the data we possess to-day the Helmholtz theory of the vowels would assert that the cavity tones may bear any relation to the larynx tone. The whole thing follows so easily and naturally from the facts that he would have drawn the unavoidable conclusion, and not have become involved in the difficulties and impossibilities caused by asserting that this relation must be harmonic.

Of course, this has nothing to do with the Fourier analysis. This method gives us a plot of what harmonics might be used to reconstruct a curve. The profile of a face can be resolved into a series of harmonics. The blunder occurs when someone supposes that this mathematical analysis proves anything physical. The analysis of the profile does not prove that the face was constituted of harmonics. As explained in my first article, the harmonic plot of a vowel wave represents a mathematical formula. As soon as we attempt to give a physical interpretation to this formula we are forced to reject the harmonic theory and to assert that the vowel tones may bear any relation whatever to the fundamental. The Fourier analysis still remains the only way of analysing vowel curves, and its results prove the independent theory of the vowel tones.

E. W. SCRIPTURE.

The Generation of Heath-fires.

Is Mr. Martin (NATURE, August 25, p. 811) certain that the fire seen by him had not spread through the peat from a neighbouring area recently ablaze? That such subterranean combustion may persist for many days and spread a long distance is common knowledge.

Experience shows that the surest way of preventing fires is to cut away the heather; whereas, on Mr. Martin's hypothesis, by exposing the loose soil to the direct rays of the sun this procedure should add a new risk.

HENRY BURY.

Mayfield House, Farnham, Surrey, August 26.

Life and Mind.

DURING the past six months NATURE has published many articles and reviews about life and mind, but there has been no clear and precise definition of these two terms; so permit me to submit for the serious consideration of your scientific readers a brief statement of what appears to be the true position of affairs :—

(1) We depend only upon evidence of what is called "matter" and its various *states*.

(2) Life is a state of certain kinds of matter when physical conditions are favourable.

(3) Mind is the state of some portion of a living organism—in man the cerebral cortex, where thousands of nerve-endings are concentrated.

This is no attempt to explain the *how* and *why*; but can the facts, if facts they be, be expressed more simply or concisely and with greater precision? The question may appear trivial, but it has an important bearing on other subjects which are alluded to from time to time in NATURE.

SESAMY.

The Stream of Life.[1]

By PROF. ARTHUR DENDY, F.R.S.

ALL typical organisms—animal or vegetable—are composed of cells; minute nucleated masses of protoplasm, existing either singly or in many-celled aggregates. These cells are capable of reproducing themselves by a process of division, and each of the higher organisms, with certain negligible exceptions, starts its life in the condition of a single cell which we call an egg or ovum, or, to use a more general term, a germ-cell.

Whatever may have happened in the far-distant past, at the present day, so far as we can see, every living thing is the product of some pre-existing living thing, the relation of parent and child holds good throughout the whole organic world, and when we come to analyse this relationship from the biological point of view we find that it is always essentially based upon cell-division. Leaving out of account, as we may legitimately do for our present purposes, the stages of protoplasmic evolution that precede the appearance of the nucleated cell, we may say that the cell is the unit of organic structure, that all organisms are built up of such units in somewhat the same way as a house is built up of bricks, except that the process of building in the living organism is one of cell-growth and cell-multiplication, while the bricks of a house are brought together and combined into a building by some external agency. This fundamental conception of organic growth leads to the still more fundamental conception of living matter as a continuous stream of protoplasm, starting with the first appearance of life on the earth and continuing to the present day with undiminished vigour; but it is a stream which in the process of time constantly branches out in new directions, giving rise ever to more complex and more diversified types of plants and animals. It is the stream of life. To make use of a more familiar metaphor, the whole organic world may be compared to a great tree, the roots of which are dead and buried in the past, and the leaves and flowers of which, individualised and endlessly diversified, are represented by the living plants and animals of to-day.

Let us now examine a little more closely the means by which successive generations of organisms, parents and offspring, are linked together. We have to ask ourselves the question: Why do all except the simplest organisms reproduce themselves by means of eggs, instead of simply dividing up into equivalent parts? In other words, why does every plant and animal of a new generation have to go back to the beginning and start its life as a single cell? We may approach this question by considering for a moment a once familiar domestic operation—the baking of bread. You have no doubt sometimes heard the expression "half-baked" applied to human beings, which shows that the analogy I propose to make use of is not altogether new. If we want to increase the number of our loaves it is no good simply cutting them in halves. We must go back to the dough and out of it fashion new loaves. The dough, properly prepared, contains all the ingredients necessary for bread-making and is capable of developing into loaves when subjected to the right treatment. When once it has developed into a loaf, however, it cannot be turned back again into dough.

So it is also with the living organism. When once the protoplasm of the egg, or germ-plasm, as it is technically termed, has developed into the mature tissues and organs of the adult body, it cannot, usually at any rate, be turned back again into germ-plasm; it continues to live for a time, but the stress and strain of life gradually exhaust its vitality; for a time, tissues and organs may be renewed, but ultimately some essential part of the mechanism of the body is worn out beyond the possibility of repair, and the death of the entire organism inevitably follows.

What provision, then, is made for the next generation—who mixes the next batch of dough? Here I am afraid our analogy breaks down, and it breaks down just because the germ-plasm, unlike the dough, is a living substance capable of increasing itself indefinitely by growth and multiplication. What happens is typically this—a part of the original germ-plasm of each generation is set aside, taking no share in the development of the body, but remaining in the condition of comparatively undifferentiated protoplasm, while continuing to increase and subdivide into germ-cells. It thus appears that the old idea that the hen produces the egg is scarcely correct—it seems that the egg produces the hen and at the same time more eggs, which are accidentally, as it were, included in the body of the hen. The constant succession of germ-cells, each produced by division of a parent cell, constitutes the only really continuous stream of living protoplasm. The bodies of individual plants and animals, developing from the germ-cells, may be compared to local and temporary overflows from the stream, which sooner or later dry up and disappear, or, in other words, die. This is Weismann's well-known doctrine of the "continuity of the germ-plasm," and for our present purposes we may take it as substantially correct, in principle if not in detail.

The simpler living organisms, which, like the amœba, consist each of only a single cell, are exempt from death, because in them the stream of protoplasm forms no overflows; it consists entirely of germ-plasm, and no differentiated bodies are formed, so that there is nothing to die, nothing which cannot go on reproducing itself indefinitely. Death is the penalty paid for a higher

[1] From a citizens' lecture delivered at Edinburgh on September 8 during the meeting of the British Association.

life, based upon a greater complexity of bodily mechanism.

In all that has been said hitherto, which must be already very familiar to most of you, we have been endeavouring to pave the way for the consideration of what is perhaps the most difficult and certainly the most vigorously discussed problem of biology—the problem of heredity. With regard to single-celled organisms such as the amœba, this problem scarcely exists. Division of the parent cell entails division of all that that cell possesses. The daughter-cells resemble the mother simply because they are that mother divided into two equal and similar parts.

With the higher organisms, each composed, perhaps, of many millions of cells, differentiated into many different kinds, and building up the most diverse tissues and organs, the situation is very different. In such a case how can a single, apparently undifferentiated, germ-cell, which has never taken part in the formation or in the activities of the body as a whole, and exhibits none of the features which characterise the tissue-cells—how can such a simple cell give rise by growth and multiplication to all the different kinds of cells, arranged in all the different tissues and organs, more or less exactly as in the parent?

The development of such an infinitely complex organism as, for example, the human body, from a microscopic egg-cell of apparently simple structure, seems, indeed, a kind of miracle, and the more closely we compare parent and child the more miraculous does the result appear, for not only is there a general resemblance in all essential features, but there is very frequently also a particular resemblance in minute peculiarities, such as the colour of the hair or eyes, the contour of the features, and so on.

It would be claiming far too much to say that we have as yet arrived at any complete explanation of heredity—this marvellously accurate reproduction in the child of the most minute details of bodily and mental organisation exhibited by the parent. But the explanation is, perhaps, after all, not quite so difficult as it seems at first sight. Let us go back to our loaves of bread and ask ourselves why one loaf resembles another. Why does the loaf that is baked on Tuesday resemble that which was baked in the same oven on Monday? The answer is obvious. One loaf resembles another because it is made from the same kind of dough and subjected to the same kind of treatment. If you take a different kind of dough, or subject the same dough to a different treatment, you will get a different result—and, as every housewife knows, there may be a vast difference between the loaves turned out by different bakers. The characters of the loaf clearly depend upon two sets of conditions: first, the nature of the dough itself, whether, for example, it is mixed with yeast or baking powder, water or milk, salt or sugar, and so on; and, secondly, the nature of the treatment to which the dough is subjected, the shape of the tins in which it is baked, the temperature of the oven, and so forth. If all the conditions are accurately repeated for successive batches of loaves, then the loaves of each batch will resemble those of the preceding batch.

We have in this respect a very close analogy with what takes place in heredity. The egg consists of a certain quantity of germ-plasm, and this germ-plasm has certain characteristic peculiarities of its own. In order that it may develop into an adult organism like the parent, it must be subjected to a certain treatment. In the case of a hen's egg undergoing incubation, or of the human fœtus developing in the womb of the mother, we may truthfully say that it has to be baked in an oven at a particular temperature. Only if all the conditions are accurately fulfilled will the egg develop into an organism resembling the parent, and it does so simply because the same causes must always produce the same effects. If you start with identical germ-plasm and expose it to identical conditions during its development, you must get an identical result. The child must resemble the parent. It is, indeed, easy to show by experiment that if you vary the conditions you may get either no result at all or a different one. Up to a certain point, however, the living organism has the power of counteracting accidental influences, and thereby maintaining its normality of structure. In other words, it is self-regulating, and seems to be always endeavouring to carry out the plan of structure characteristic of the species to which it belongs, so that, if this plan be disturbed, it will, within limits, be restored again by appropriate growth and readjustment. This power of adhering to a predetermined structural plan, in spite of disturbing influences, is one of the most distinctive attributes of living beings, and must on no account be lost sight of in considering the problem of heredity; but at the same time it is a power that is strictly limited.

A well-known American investigator, Prof. Stockard, has recently shown, in the case of various animals, how abnormalities can be produced by simply lowering the temperature during development. Some years ago the same observer obtained even more surprising results by the use of a simple chemical reagent. He exposed the eggs of the American sea-minnow (Fundulus) to the action of magnesium chloride, and found that the young fish tended to develop with a single eye in the middle of the head, instead of one on each side, though the modification was not in all cases complete. Thus we see that it is possible, by the application of a specific chemical stimulus to the egg, to bring about a profound and perfectly definite change in the structure of the organism, though we are still far from knowing why this should be the case.

We also know, from recent physiological research, that the growth of various organs in the animal body is normally controlled by infinitesimal quantities of chemical substances secreted by the ductless glands, such as the thyroid and the pituitary, and circulated in the blood, and that any

deficiency or excess of these substances may produce abnormal results. The discovery of these hormones, as they have been termed by Prof. Starling, must have a profound influence on our ideas as to the mechanism of heredity. Their significance from this point of view was, I believe, first pointed out by Mr. J. T. Cunningham many years ago. It seems at least possible that chemical substances of a like nature may exist in the germ-cells and exercise a profound influence upon their development.

With this possibility in view, let us again examine the egg-cell at the very commencement of its development into a multicellular body, at the moment of its division into the first two daughter-cells, and let us concentrate our attention upon the nucleus, which always divides first. As it prepares itself for this important event a number of peculiar bodies called the chromosomes make their appearance, apparently by concentration of previously scattered granules of chromatin substance, so-called because of the way in which it can be stained by certain dyes. At the same time, a spindle-shaped arrangement of threads becomes manifest and the nuclear membrane disappears, so that there is no longer any sharp division between nucleus and cell-body. The chromosomes, often varying in shape and size amongst themselves, but definite and constant for each kind of organism, arrange themselves across the middle of the spindle. Then each splits into two, and one half moves away from the other and towards the corresponding end of the spindle. We have now two groups of daughter-chromosomes, and around each group a new nucleus is constituted. Then the protoplasm of the cell-body divides into two parts, and two complete cells are formed, each with its own nucleus.

The process is really far more complicated than this brief and inadequate description might lead you to suppose, but the essential feature seems always to be the behaviour of the chromosomes. It is very evident that the protoplasm of which these are composed must be of the utmost importance to the organism, and that it is necessary that it should be very accurately divided between the daughter-cells every time cell-division takes place. This phenomenon of mitosis, as it is termed, is of almost universal occurrence throughout the animal and vegetable kingdoms, not only in the early divisions of the egg-cell, but throughout the entire life of the organism, whenever cell-division takes place. It is clearly a contrivance by which a certain material substance—a particular kind of living protoplasm—is accurately distributed amongst the progeny of a dividing cell In other words, it is part of the mechanism of inheritance.

Let us now turn aside for a moment and glance very briefly at another and totally different line of evidence, leading to results which confirm and explain in a very remarkable manner those which we have already arrived at. I refer, of course, to the modern experiments in the breeding of plants and animals, undertaken under the influence of what is frequently termed the Mendelian school. It is utterly impossible to do justice to these wonderful experiments in the time at our disposal. I would point out, in the first place, however, that they have led quite independently to the striking conclusion that there must exist in the protoplasm of the germ-cells definite material entities—the so-called Mendelian factors—which are in some way or other responsible for the appearance in the adult organism of special features—the so-called unit characters—capable of being handed on from one generation to another by the process of heredity. Assuming them to be located in the chromosomes, the behaviour of these factors in inheritance, the permutations and combinations of unit characters which arise in cross-breeding, can be adequately explained by the behaviour of the chromosomes actually observed at certain critical periods of the life-cycle.

Take, for example, the colour of the human eye. If a certain factor, or combination of factors, alone be present in the germ-plasm, the eye will be blue or grey, but the addition of another factor may cause it to be brown, and the average results, as regards eye-colour, of mating pure blue-eyed and pure brown-eyed individuals can be confidently predicted. The occasional appearance of an extra thumb or finger upon the hand, which is well known to be a heritable character, transmitted with great regularity from parent to child, is again supposed to be due to the occurrence of a corresponding factor in the germ-plasm, and so on with a whole host of characters that have been carefully investigated by means of breeding experiments in recent years. It is important to note that these characters seem to bear no purposeful relation whatever to the well-being of the organism in which they occur. They are often extremely insignificant, and a large proportion of them must undoubtedly be regarded as abnormalities. It is a mere matter of chance whether they happen to be useful, neutral, or injurious.

We cannot attempt to discuss, or even state, however briefly, the evidence upon which this factorial hypothesis rests. Suffice it to say that it seems to afford the only possible explanation of the results of the long series of experiments inaugurated in Austria by the classical work of Mendel in the middle of the last century, carried on by Bateson, Punnett, Biffen, and others in England, and culminating in the brilliant investigations of the American school of geneticists under the leadership of Morgan.

The investigations of Prof. Morgan and his colleagues have gone so far as to demonstrate conclusively, albeit indirectly, not only that the Mendelian factors must be located in the chromosomes of the nucleus, but also that they must be arranged in each chromosome in a perfectly definite manner. These observers have even prepared maps of chromosomes showing the arrangement of the

factors in linear series. It is surely one of the most remarkable achievements of modern science that we should be able to point to a particular spot in a particular chromosome of a microscopic germ-cell and say with confidence that there is something just there that is responsible for some particular character, such as the colour of the eye, in the adult organism.

As to the nature of the factors themselves, it seems not unreasonable to conclude that they must consist of definite chemical substances, or, perhaps better, of chemical modifications of living protoplasm, in the form of minute particles too small to be rendered visible by any means yet discovered, but capable of self-multiplication like other protoplasmic units.

We may further suppose that these factor-forming substances play a part in controlling the development of the organism comparable with that played by magnesium chloride in the case of the developing embryos of the sea-minnow, or by other chemical substances (hormones) in the normal adult animal. The complex mechanism of mitosis in the division of the cell-nucleus would then appear to be necessary in order to secure the proper distribution of factors throughout the growing body, so that each may reach the particular part that it is destined to influence.

It must be remembered that the occurrence of Mendelian phenomena in heredity depends entirely upon a much more fundamental phenomenon —that of sex—which gives the experimenter the opportunity of crossing two individuals differing as to one or more separately heritable characters, and of observing the numerical proportions of the offspring in which each of these characters makes its appearance.

The phenomenon of sex, as we all know, is a very great mystery, and introduces endless complications into life. Sexual differentiation appears to be nearly as old as the cell itself. The stream of life, almost since it first began to flow, has been a double stream, or, better, a network, in which male and female streamlets unite at more or less frequent intervals to form those temporary overflows which we call individuals. Each streamlet goes its own way for a time, and then joins and exchanges experiences, so to speak, with another. It is just this exchange of experiences that forms the basis of the Mendelian phenomena, and it is not merely the experiences of a single lifetime, but those of many generations that may be thus exchanged.

Perhaps, however, we are getting a little too metaphorical and had better consider in a rather more matter-of-fact manner what actually takes place in the sexual process. The essential feature of this process is always the same—the union of two germ-cells to form a single cell, although this fundamental act is greatly obscured in the higher plants and animals by the endless contrivances which have arisen in the course of evolution, and which serve the ultimate purpose of bringing the germ-cells together. In all the higher animals and plants these germ-cells are sharply differentiated into male and female, spermatozoa or sperm-cells and ova or egg-cells, and, with rare exceptions, the egg-cell cannot even begin to develop until it has united with, or, as we say, been fertilised by, a sperm-cell. This is very literally the union of two branches of the stream of life.

From the point of view of the theory of heredity, the most important thing about this union is the coming together of two sets of chromosomes—paternal and maternal—the one set coming with the spermatozoon from the male parent, and the other with the ovum from the female parent. The maternal and paternal chromosomes bring with them factors that have arisen in some unknown way, probably by chemical changes, in the two ancestral streams of protoplasm which unite in the fertilised egg. Apart altogether from the much-vexed question of the inheritance of "acquired" characters, which we cannot even touch upon this evening, these factors represent certain experiences which the stream of life has gathered on its journey.

Hence the new organism may exhibit certain characters derived from the father and others derived from the mother, a combination of paternal and maternal peculiarities, while the fundamental features of its organisation cannot be said to be derived from one parent more than from the other. It will resemble either parent just in so far as it starts life with the same potentialities, inherent in the germ-plasm as a whole and in its special factors, and just in so far as it develops under identical conditions. (We must not forget, though the point is not essential to our argument, that the germ-cells may perhaps contain other special factors besides those which have been located in the chromosomes.)

It is a curious fact, and one upon which our social reformers and preachers of equality would do well to reflect more seriously, that the characters, the potentialities for good or evil, of a living being should depend so much upon mere chance. A great deal can be done for the welfare of the individual by improving the conditions under which it lives, as every gardener knows, but nothing can altogether counteract the effects of hereditary tendencies. It is worth while to consider a little more fully how it comes about that chance plays such an important part.

With certain exceptions, which do not affect the general proposition, every cell of the living organism contains, as we have already seen, a double set of chromosomes, one set derived from the male and the other from the female parent. The duplication takes place at the time when the two germ-cells come together to form the fertilised egg, but it is counteracted again by reduction at another period of the life-cycle; otherwise the number of chromosomes in each cell would continue to increase in geometrical ratio from generation to generation, which is clearly impossible. It is at these two critical periods that chance steps in and prepares her surprises.

In the first place it seems to be purely a matter of chance what luck the germ-cells have in their mating, what particular ovum is fertilised by what particular spermatozoon, and, owing to the enormous numbers in which ova and spermatozoa are produced, the possibilities may be almost infinite. In the second place there are many alternative possibilities with regard to the particular factors which any given germ-cell, male or female, may contain. This depends upon which particular chromosomes happen to remain in the germ-cell after the double number has been halved again. In animals this halving takes place at the time when the germ-cells are ripening, shortly before they are ready to unite in the fertilised egg. The maternal and paternal chromosomes in each, differing as regards the factors they contain, pair off during the process of mitosis. The members of each pair then separate, and one of them alone remains in each mature germ-cell. Hence the germ-cells, even of the same individual, come to differ amongst themselves to a practically unlimited extent as regards their factorial constitution. The life of the individual is like a game of cards, in which a very great deal depends upon the shuffling of the pack, and the player has to do the best he can with the hand dealt out to him. He may make a hopeless failure of it, or a great success; but still the stream of life flows on, ever gathering and combining new experiences, ever forming itself into fleeting individualities and leaving them to perish on its banks as it passes on to fresh attempts at self-expression.

The interest of the Mendelian breeding experiments is so absorbing that it is little wonder if more fundamental aspects of the problem of heredity, to which we have alluded in the earlier part of our lecture, have been largely lost sight of in recent years, while the factorial hypothesis has been hailed by some extremists as the all-sufficient explanation of everything. The characters of the organism may indeed be modified by factors in the germ-plasm, just as the character of a loaf may be modified by putting caraway seeds into the dough; but the caraway seeds do not explain the loaf, and the Mendelian factors cannot explain the organism as a whole. There is doubtless a good deal of truth in the old saying that life is made up of trifles; but it is not the whole truth, and the body of a living organism cannot be regarded as merely the sum-total of its unit characters.

Whatever may be their significance from the point of view of the general theory of evolution and heredity, however, there can be but one opinion as to the immense practical importance of the Mendelian investigations. They have already led to the production of many valuable forms of life, more especially plants, that are to all intents and purposes new creations, although their value and novelty may depend merely upon the bringing together of desirable characters in new combinations and the elimination of undesirable features.

Nor are the possibilities of improvement by selective mating confined to our domesticated plants and animals. Hopes are entertained by many enthusiasts, banded together in the interests of what they have thought fit to term the science of Eugenics, of effecting vast improvements in the human race itself by the application of Mendelian principles. It does not seem likely, however, or even desirable, that men and women should ever consent to be guided in their choice of mates by purely utilitarian considerations.

There are many objections to any far-reaching schemes of this kind, but it does seem possible, when once the facts of heredity are generally known, that the exercise of an enlightened public opinion and individual choice may result in the elimination from the stream of human life of many heritable characteristics which it is very undesirable to perpetuate. In extreme cases, such as feeble-mindedness and certain forms of insanity, it may even be necessary for the community to protect itself by legislation against the criminal propagation of the unfit.

What is wanted, first and foremost, however, is education, and I trust that you will agree with me that it is education in biology—the science of life—to which we may most hopefully look for the physical and mental improvement of the human race. Men and women must learn to realise their responsibilities towards future generations from the biological point of view, and it is in this direction that the citizens of a great city like Edinburgh can best help, by generously supporting the cause of education and research as represented by your ancient and world-famed University.

Speech through the Æther.[1]

By Sir Oliver Lodge, F.R.S.

An intelligent deep-sea fish would disbelieve in water. It would be too uniform and omnipresent to make any impression on its senses. Near the surface it might encounter waves and currents, but to creatures thoroughly embedded in its depths water would make no display. Such is our own condition with regard to the æther of space. It eludes direct perception; its existence cannot be directly demonstrated; it has to be inferred.

The fish would probably also disbelieve in gravity, since it would not experience it, and some of the hyperintelligent among us, for quite another reason, seem to be following its example; but that is another story. Suffice it to say that direct sensation is but a poor clue to reality unless supplemented by a great deal of reasoning and indirect inferences. Our senses tell us only about

[1] Abstract of a citizens' lecture of the British Association delivered at Edinburgh on September 6.

matter, and to believe in anything else makes some call upon the imagination. By aid of cultivated imagination, however, the permanently deaf may appreciate something of the meaning of music, and the permanently blind may apprehend dimly the beauty of a landscape. So it appears from the experience of Helen Keller.

Let us grant, then, that the æther impinges on us only through our imagination; that does not mean that it is unreal. To me it is the most real thing in the material universe. It is not matter, but it seems to be the stuff of which matter is made. It holds the atoms together, and it welds the cosmos into a coherent whole. It penetrates the pores of matter even into the innermost recesses of atomic structure, and it extends to the furthest confines of visible space. By its aid we see and analyse the nebulæ at distances too vast for anything but mind. Through it, too, we do more prosaic things—we telegraph and we run electric motors—even tramcars—guiding the energy by a wire itself inert. Briefly summarised, the æther is responsible for cohesion, for chemical affinity, for electric and magnetic forces, for light, aye, and, as we learn from Einstein, for gravitation too. Is there anything the æther does not do? Yes, it does not convey sound. Sound is a vibration in matter, not in æther, while light is a tremor in æther, not in matter. We see through the æther; we do not talk through it.

But my subject is "Speech through the Æther," speech by means of what we call empty space. How can that be? How can we utilise the æther for conveyance of sound?

Only by transmutation. The æther has long been used to convey heat, yet heat is a property of matter. Heat from the sun reaches the earth, but it does not travel as heat. At the sun the quiver of the particles is transmitted to the æther, it spreads out as radiation, and where that falls it can excite a similar quiver. The heat disappears in one place, to reappear in another. It travels continuously as energy, but not as heat.

So it is with sound also. The sound-vibrations must be transmuted, must be delivered up to the æther to travel as radiation, and at the distant station it must be received by something which can transmute the energy back to sound again.

The transmutation of heat from matter into ætherial energy was effected by the atoms themselves by mechanism only partially known to us. Through all the geological ages—literally from time immemorial—it has been going on. Not so with sound. No trace of sound reaches us from an exploding star. We see the flash; we hear nothing. To transmute sound into an ætherial tremor and to change it back again into sound at a distant station requires human agency. It needed discovery and invention. Discovery and invention are rife among us though handicapped in their early stages by poverty and lack of opportunity. Only when some practical result is forthcoming does that difficulty begin to disappear. Faith in the power of discovery, latent in not a few of our strenuous youth, would accelerate the process. Faith removes obstacles and gives to genius its chance. Other nations will soon be beginning to realise this if we do not.

Great achievements are not due to one man, but to a succession of workers, each passing on the torch to the next. Each man's life is too short for extensive achievement. The great building rises, stone by stone, but it takes generations to complete—nay, it is never completed.

The long chain of discoverers has no end and no specifiable beginning. One can but pick out a few salient peaks. Nor is it one line only; it is a branching line. Different paths seem to converge on some one goal. It is well to remember great names of recent times—Kelvin, Maxwell, FitzGerald, Hertz, the pioneers on one line, and on another Crookes, J. J. Thomson, and others who are working hard to-day. The first line dealt with the æther and its properties; the second line discovered the nature of electricity.

It is only with scientific principles that I am dealing, not with the technical details of application. Methods of application are protean; many an amateur is acquainted with them, and the subject is advancing so quickly that devices a few years old may hiss the speaker; each twelvemonth teems a new one; but the fundamental principles remain, and one of these is the nature of electricity. It has turned out to be corporeal, atomic, or, rather, electronic. The discovery which closed the nineteenth century was the isolation of the natural unit of electricity. Small almost beyond conception, mobile and active to an extraordinary degree, the electron is becoming our most docile servant. The skill of man has harnessed electrons, and it is by their aid that sound-vibrations can be transmitted to the æther, and, after transit across great vasts of space, can be transmuted back again. In an empty Crookes's tube they can be driven off from matter. From a hot wire they evaporate, and they can be deflected and guided as we wish. Their obedience is absolute and instantaneous; they have next to no inertia or sluggishness of their own, and they obey the slightest force. An electric pole attracts or else repels them, according to its sign, and so their motions can be encouraged or can be checked.

If faced with a positive plate they rush to it; if the plate is negative they retire discouraged. Their journey is itself an electric current, and thus we get an electric current varying and responding to every fluctuating control. Electric oscillations are known. We owe them to Kelvin and FitzGerald. They are of extraordinary frequency—millions of vibrations per second—and they generate waves in the æther, as was shown by Maxwell and Hertz.

Let us, then, arrange a microphone, an ordinary telephone transmitter to which we can talk in the ordinary way, and let the slow sound-vibrations—a few hundred per second—be applied to strengthen or weaken electric oscillations of a few million per second. Thousands of oscillations

occur during the time that every sound-wave lasts, and by letting them control a crowd of electrons in an exhausted vessel or vacuum tube their intensity can be controlled by every ripple, every rustle, every shock, and every sibilant which go to constitute human speech; and the radiation emanating from the electric oscillations will then be graduated in intensity so that the waves which travel in the æther shall be strong or weak exactly as the stimulus requires.

Receive the electric waves and convey them to another empty bulb containing again a hot wire giving off electrons; the crowd of particles respond, another current is generated, carved into fluctuations of corresponding strength, and these variations of current, when employed to actuate a telephone, can accurately reproduce the tones of the distant voice.

Roughly and generally that is the plan, and the astonishing feat is carried out by various ingenious devices. I was not specially astonished by the wireless transmission of coarse signals like the dot and dash of ordinary telegraphy. It is no more difficult to send impulses across space than to guide them by wires. What Mr. Marconi has made practical as "wireless" might have come in first, and then wires might have been regarded as an improvement, like speaking through a tube instead of shouting into the open air. Any mechanical sending key and many a mechanical relay can accomplish that, but no mechanical relay could follow the variations of quality in human voice; no agency short of the electron would be quick and docile enough; but with their aid the feat is accomplished, and the electric waves which act as the intermediary can travel a thousand miles or more before being received and once again transmuted.

One more principle I must emphasise. How can the human ear or any instrument follow vibrations of millions a second? It cannot. Only the electron can do that. But suppose that, in addition to the oscillations coming from a distant station, we set up home oscillations in a small subsidiary vacuum tube of nearly the same frequency. Let the incoming waves vibrate a million times, for instance, while our local arrangement vibrates a million *plus* 500. What will happen? They will "beat." They will give 500 beats a second, and that is a musical note. To that we can listen, and upon that the variations of intensity can be superposed.

This is not the first plan adopted. The first plan was the utilisation of crystals and other detectors, such as the Fleming valve, to rectify the oscillation, to check all the negative pulses and utilise all the positive, to let only one sign through. Thus we got the vacuum valve. But soon this was improved by Lee Forest into a magnifier, so that an original impulse, exceedingly weak, could be strengthened a hundred or even a thousand times by using the electrons as relays and putting a number of relays in series.

So also for transmitting, the magnifying device is available. The electric impulses from the first valve, the one directly actuated by the microphone —these need not be given to the æther; they can be used to stimulate another valve, so as to increase their intensity until the waves generated are powerful enough to be allowed to rush across the Atlantic. This they are able to do in a fraction of a second. And there, though what arrives is only a feeble residue, since they have spread far and wide by that time, yet they preserve all their peculiarities intact, every pulse of the speech is retained and can be reproduced, and by adequate magnification can be made easily audible.

Distance is no deterrent; it only enfeebles; it does not confuse and spoil, as it does with a wire embedded in the ocean. The properties of the æther are perfect, and all the fluctuations are accurately conveyed. All that we require is a magnifier to get a convenient intensity, and that the ingenuity of man has supplied. We have learnt to communicate efficiently across space void of matter. Possibilities are thus opened up the end of which no man can foresee.

Variations of Climate since the Ice Age.[1]

By C. E. P. BROOKS.

THE nineteenth century envisaged the Ice age as a remote catastrophe, sharply separated from the changeless present. The past twenty years have reversed that view; geologists and botanists have traced considerable fluctuations of temperature and rainfall extending from the last (Würmian) glacial period into historical times, while archæologists, working backwards from the present, have met them at the dawn of history with conditions appreciably different from those of to-day. In the countries bordering on the North Atlantic at least, the facts have been laid down with security, and it is now the task of meteorologists to elucidate the various distributions of pressure and winds which were associated with these changes of climate.

At the present day the great ice-sheets of Greenland and the Antarctic Continent are occupied by permanent areas of high pressure, and we may infer that the Quaternary ice-sheets of northern Europe and North America were occupied by similar anticyclones, with dry easterly winds on their southern borders. In Europe at least there is direct evidence of this in a belt of "fossil dunes" extending from Russia to Holland; these dunes are crescent-shaped with their convexities to the east, indicating that they were formed by easterly winds. The Atlantic must have been a

[1] Abridged from a paper in the Quarterly Journal of the Royal Meteorological Society, July, 1921, pp. 173–94.

centre of storm development then as now, but the anticyclone over northern Europe prevented these storms from taking their present northern track and forced them into the Mediterranean, where they brought increased rainfall and a "pluvial period." These meteorological conditions are indicated in Fig. 1. (The illustrations are reproduced by permission of the Council of the Royal Meteorological Society.) By reference to the estimates of Penck and Bruckner in the Alps and to the "geochronological" work of Baron de Geer in Sweden, this map is considered to represent conditions prevailing until about 18,000 B.C.

The presence of the ice-sheet is attributed to elevation in Scandinavia (see NATURE, vol. 102, p. 335). With the subsidence of the land the ice

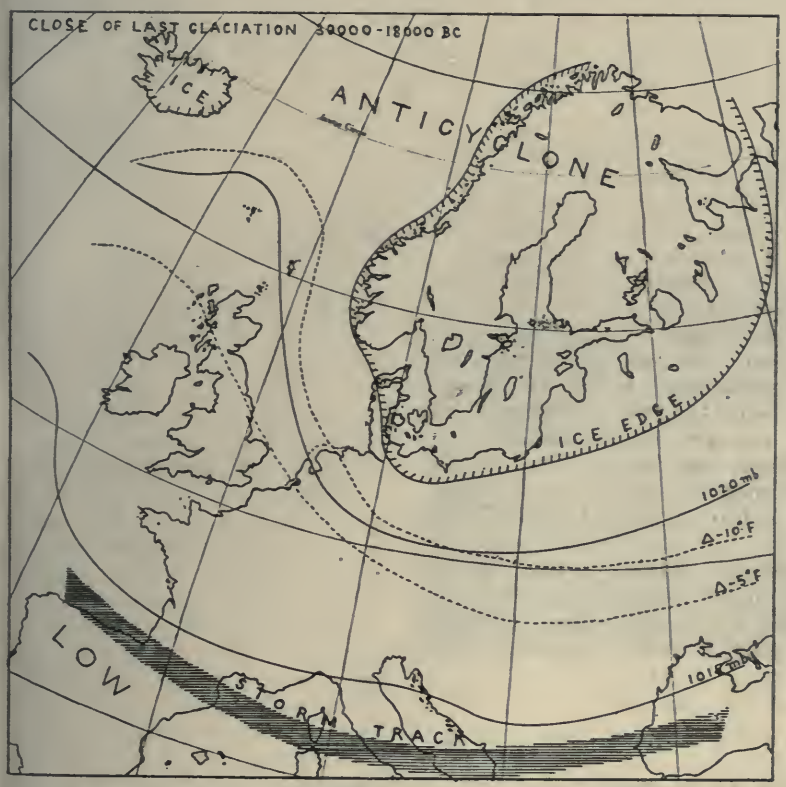


FIG. 1.—Pressure and temperature distribution at the close of the last glaciation.

receded, slowly at first, then more rapidly, but about 8000 B.C. and again at 5000 B.C., when elevation temporarily closed the connection between the Baltic and the Atlantic, there were halts or slight readvances forming the great Scanian and Ragunda moraines. At the same time the Alpine glaciers, which throughout seem to run parallel with the Scandinavian, formed the moraines of the Gschnitz and Daun stadia.

Until 6000 B.C. the ice-sheet was still large enough to maintain a border of dry Arctic conditions on its southern edge, but the mean annual temperature of southern Sweden rose from 17° F. to 35° F. After 6000 B.C. the Ice age is regarded as over, and the subsequent climatic history can be divided into a series of "phases," as follows:

	Phase.	Climate.	Date.
1.	The Continental Phase	Continental	6000–4000 B.C.
2.	The Maritime Phase	Warm and moist	4000–3000 B.C.
3.	The Later Forest Phase	Warm and dry	3000–1800 B.C.
4.	The Peat-bog Phase	Cooler and moister	1800 B.C.–300 A.D.
5.	The Present Phase	Becoming drier	300 A.D.–Present

About 6000 B.C. elevation closed the outlet to the Baltic for the second time, converting it into the large freshwater *Ancylus* lake. This shutting out of the Atlantic accentuated continental conditions in Scandinavia. The winter climate was severe; at first during the formation of the Ragunda moraines the summers were not especially warm, but later they became hot and dusty. The rainfall was scanty, and the general climate resembled that of South-east Europe. Throughout this phase Scandinavia was occupied by a rich forest flora, and towards the close conditions were very favourable to tree-growth. The hazel extended several degrees north of its present position and to higher levels, indicating a July temperature about seven degrees higher than the present. But the ivy and yew, the limits of which depend on the winter rather than on the summer temperature, showed no such extension, indicating that the winters remained severe. The absence of storms off the north-west coast of Norway is shown by the forests, which at this period covered all the outermost islands as far as the Ingo Islands off North Cape. These islands are now barren, and their afforestation indicates a drier and less stormy climate than the present, with a decreased frequency of winds from the sea. These continental conditions, however, did not extend so far west as Ireland. As the glacial anticyclone decreased in intensity, depressions from the Atlantic began to take a more northerly course, but were held up near the British Isles and materially increased the rainfall there, forming the first peat-bogs of the western coasts. It seems probable, however, that southern and eastern England largely escaped this damp period, sharing in the dry climate of the Continent.

About 4000 B.C. submergence once more allowed the Atlantic waters to flow into the *Ancylus* lake through a wide strait, much broader than the present outlet, forming the *Litorina* sea, which was appreciably larger than the present Baltic, and the Continental Phase gave place to a Maritime Phase, very moist and equable. Depressions now passed freely into the Baltic region, rainfall was heavy, and peat-bogs began to form over extensive areas. This favourable climate was best developed in the Baltic countries where submergence was greatest, but the whole of the North Atlantic and neighbouring parts of the Arctic shared in it to some extent,

for raised beaches about 25 ft. above the present level with a warm fauna extended from the east of North America to Spitsbergen and the White Sea. This suggests some general factor which by altering the circulation of the North Atlantic piled up its waters in cold temperate and polar latitudes, producing a period of widespread development of warm maritime climates termed the "Climatic Optimum."

By 3000 B.C. another wave of elevation affected the southern half of the British Isles and neighbouring parts of Europe, which stood about 90 ft. above their present level. At the same time the climate became drier, and a magnificent growth of forests occurred even on the bogs of Ireland, which were extensively inhabited by Neolithic man. Many shallow lakes were more or less dried up and trees grew on their floors (Fig. 2); this is the Later Forest Phase. Tree stools in exposed situations in the west of Ireland, as well as evidence of considerable sea-borne

FIG 2.—Submerged tree stools in lough, Ireland.

commerce between Scandinavia and the British Isles, testify to an absence of strong winds. Conditions were anticyclonic, with possibly cold winters, but with fine, warm summers and a relatively small rainfall. Neolithic civilisation rose rapidly to its culminating point, especially in naturally moist countries like Norway and Ireland. This period, in fact, appears to coincide with the legendary Heroic age of Ireland, when the vigour of the Irish reached a level they have never since attained, an interesting confirmation of Ellsworth Huntington's theory that at present the high humidity of that country lowers the energy of its inhabitants.

By 1600 B.C. the land had again sunk to its present level, or possibly a few feet lower. The favourable anticyclonic conditions gave place to great storminess with relatively heavy rainfall, and there set in a period of intense peat formation in Ireland, Scotland, Scandinavia, and North Germany. This growth went on even over high ground which had not previously been covered by peat, for in Ireland tumuli of the Bronze age are found resting on rock and covered by several feet of bog. As the Bronze age gave place to the Early Iron age the climate of North-west Europe became very unfavourable, and the submergence of the early civilisation is described in Norse sagas and Germanic myths—the "Twilight of the Gods," when frost and snow ruled the world for generations (about 650 to 400 B.C.). Peat formation went on even over the Frisian dunes.

This wet period, whatever its cause, was widespread, as is shown in Huntington's curves of tree-growth in California and climate in western Asia; the same author also believes that the Mediterranean lands had a heavier rainfall from about 500 B.C. to 200 A.D., and the quietude of central Asia at this time suggests similar conditions there. It seems that the phase was marked by a general increase of the storminess and rainfall of the temperate regions of the northern hemisphere at least, with a maximum between Ireland and North Germany, indicating probably that the Baltic again became the favourite track of depressions from the Atlantic. The Peat-bog Phase passed into the Present Phase fairly abruptly about 300 A.D.

An interesting astronomical theory put forward a few years ago by O. Pettersson provides a possible explanation of the stormy climate of the Peat-bog Phase, which reached a maximum about 400 B.C. Without going into details, his theory is that storminess in the North Atlantic depends on the juxtaposition of masses of warm and cold water and on the presence of much ice; this is favoured by increased strength of the tides. The "tide-generating force" passes through a series of cyclic fluctuations, and according to his calculations reached maxima about 3500 B.C., 2100 B.C., 350 B.C., and 1434 A.D. That of 2500 B.C. comes into, and may have contributed to, the Maritime Phase; that of 2100 B.C. falls near the middle of the Later Forest Phase, and has left no trace; but that of 350 B.C. coincides accurately with the period of maximum storminess of the Peat-bog Phase. The stormy period round about 1400 A.D. is well known, and has been attributed by other authors to an absolute maximum of sunspots. The corresponding minima were in 2800 B.C., 1200 B.C., and 530 A.D., but of the first of these there is no trace. The second falls in the beginning of the Peat-bog Phase, but there is evidence of seaborne traffic between Scandinavia and Ireland about 1000 B.C., suggesting an absence of stormi-

ness. The last minimum, in 530 A.D., was a time of favourable conditions and a revival of civilisation in Scandinavia and Ireland, of little ice and good weather in the neighbouring seas, and of drought in Asia.

Looking back over the whole period since the ice-sheets dwindled to inconsiderable dimensions, we find that there have been considerable variations in the climate of North-west Europe on either side of present conditions, which have been reflected in the ups and downs of civilisation in these regions. The earlier and greater changes are easily explicable at first by the gradual withdrawal of the ice, and then by appreciable changes in the land and sea distribution, but the more recent variations, of smaller magnitude and duration, pass insensibly into the slow fluctuations of the past thousand years, and for these some other cause must be adduced, *e.g.*, Pettersson's, possibly connected with the sun. Such a cause has probably always been in operation, but has been masked by the greater changes of geological time, so that its operation is traceable only in favourable circumstances, or in the magnified perspective of the last thirty centuries.

Obituary.

HENRY WOODWARD.

FULL of years and honours, Dr. Henry Woodward, late keeper of geology in the British Museum, died on September 6 at Bushey, Herts. He retained his faculties almost until the end, and continued to follow with interest the progress of the science to which he had devoted his life.

Henry Woodward was born at Norwich on November 24, 1832, the youngest son of Samuel Woodward, the well-known geologist and antiquary. His father died while he was still a child, and his education at the Norwich Grammar School ended at the age of fourteen, when he went to reside with his eldest brother, S. P. Woodward, who was then professor of natural history in the Royal Agricultural College, Cirencester. Here he pursued studies in natural science, to which he had a decided inclination, and on his brother's removal to London in 1848 as assistant in the British Museum, Henry accompanied him in the hope of obtaining some congenial employment. In 1850, however, he was compelled to return to Norwich and accept a clerkship in Gurney's Bank, where he remained for seven years and devoted himself to natural history only in his scanty leisure. At last, in 1858, he realised his ambition and became assistant in the geological department of the British Museum, where he soon took full advantage of his opportunities for scientific research, and began to make numerous contributions to palæontology. In 1880 he succeeded Mr. G. R. Waterhouse as keeper, and held this office until his retirement from the museum in 1901.

Dr. Woodward's interests were always very wide, and his first publication was a small pamphlet in 1860 on "The Prize Microscopes of the Society of Arts, with Plain Directions for Working with Them." About the same time he began to write semi-popular articles on various new fossils received by the British Museum, and made several valuable contributions to the *Intellectual Observer*, the *Popular Science Review*, and other journals. Among these may be specially mentioned his general account of Archæopteryx in 1862. He continued to prepare notes on new features exhibited by fossils of all kinds added to the museum, and among the earliest was his description of the skull of the mammoth found at Ilford, showing for the first time the true inward curvature of the tusks. He was especially interested in the mammalian remains discovered by Sir Antonio Brady in the Pleistocene deposits at Ilford, and he wrote an introduction to William Davies's catalogue of the collection published in 1874. He also devoted much attention to the later mammalian remains found during the excavation of reservoirs in the valley of the Lea, and he contributed an account of the ancient fauna of Essex to the Proceedings of the Essex Field Club. One of his later papers of the same series contained a description and discussion of a nearly complete skeleton of the extinct Sirenian Rhytina from Behring Straits, which was published by the Geological Society in 1885.

From the beginning, however, Dr. Woodward made a very special study of the Crustacea, and his chief contributions to science are detailed descriptions and comparisons of extinct representatives of this class. In 1863 he published his first paper on a Macruran from the Lias of Lyme Regis in the Quarterly Journal of the Geological Society. From 1865 onwards he prepared several reports on British Fossil Crustacea for the British Association. Between 1866 and 1878 he published his well-known monograph of the Merostomata under the auspices of the Palæontographical Society. In 1877 he contributed to the British Museum catalogues a list of the British Fossil Crustacea. In 1883–84 he wrote again for the Palæontographical Society a monograph of British Carboniferous Trilobites, and afterwards joined Prof. T. Rupert Jones in a monograph of the British Palæozoic Phyllopoda for the same society. So long ago as 1865 he co-operated with Mr. J. W. Salter in a chart of the genera of Fossil Crustacea, and in 1877 he wrote the article on Crustacea for the ninth edition of the Encyclopædia Britannica. He also made a special study of many other arthropoda, and published several papers on insects, arachnids, and myriapods from Carboniferous formations.

Dr. Woodward's influence on the progress of geology and palæontology was by no means confined to his writings. In 1864 he joined Prof.

T. Rupert Jones in founding the *Geological Magazine*, and from the beginning of 1865 until the end of 1918 he was its sole editor. He thus provided a valuable medium for publication, of which due advantage was taken by nearly all British geologists. His kindly advice and able editing encouraged and aided his contributors, and the adequate presentation of the results of much research is due to his experienced guidance. As keeper of geology in the British Museum he also continually stimulated workers, and the series of descriptive catalogues of fossils published under his official direction furnished valuable aids to progress. Nor did he overlook the amateur, whose sympathy and watchfulness can do so much for geology. He added explanatory diagrams and descriptive labels to the exhibited collection of fossils, and made the guide-books more attractive by providing them with illustrations. His genial personality made him hosts of friends, who were ever ready to do the museum such service as was possible.

Dr. Woodward also took an active part in the work of several scientific societies. He joined the Geological Society in 1864, became president in 1894–96, and was awarded the Wollaston medal in 1906. He was elected a fellow of the Royal Society in 1873. For several years he was a member of council of the British Association, and he presided over the geological section at Manchester in 1887. He was an especially active honorary member of the Geologists' Association, of which he was president in 1873–75. He succeeded Prof. Huxley as president of the Palæontographical Society in 1895, and occupied the chair until his death. He was a founder and the first president of the Malacological Society. He also became president of the Royal Microscopical Society, and for many years was one of the vice-presidents of the Zoological Society. He received the honorary degree of LL.D. from St. Andrews in 1878, and was honoured abroad by election to the foreign membership of many societies.

In 1857 Dr. Woodward married Miss Ellen Sophia Page, of Norwich, who was an able helpmate during the whole of his career, and closely associated with him in his work. She died in 1913, and her memory is treasured by those who had the good fortune to attend the frequent hospitable gatherings at her home. The eldest son was for some years Government Geologist of Western Australia, and the second son began a promising career in zoology at the Royal College of Science, but both met with a premature death. One of the five daughters, Miss Gertrude M. Woodward, has rendered valuable service to palæontology by the admirable drawings with which she has enriched many works during the past thirty-five years.

It is with much regret that we have to announce the death of Lieut.-Col. Sir Peter Johnston Freyer, which took place on Friday last, September 9. Sir Peter was born in 1852, and received his early education at Erasmus Smith's College, Galway. For his medical training he went to University College, Dublin, where he obtained his M.D. and M.Ch. in 1874; he also studied in Paris. In 1875 he was appointed to the Indian Medical Service, in which he served with distinction for a number of years, being appointed to represent India at the International Medical and Surgical Congress held at Rome in 1894. He was the recipient of the Arnott Memorial Medal in 1904 for original work in surgery. After retiring from the Indian Medical Service Sir Peter set up in practice as a consulting surgeon in London, and also acted as consulting surgeon to Queen Alexandra's Military Hospital and to the Eastern Command. He was best known for his work on surgical diseases of the urinary system, and particularly of the prostate gland, in connection with which he devised the operation now in general use for its removal in cases of enlargement. For his services to the community he was created C.B. in 1917, and advanced to K.C.B. later in the same year.

By the death of Major G. H. Norman, at the Cambridge Hospital, Aldershot, aviation has lost one of its few scientific enthusiasts. An unusual combination of knowledge with expertness as a flyer had marked him out for important research under the Air Ministry, and one of his recent striking successes was the analysis of the causes of fire in aeroplanes, particularly after a crash. The more important defects were soon detected, and remedies for them suggested and put into effect. Before his death the point was reached at which a number of equally probable causes were shown to exist, and attention is being directed to their elimination.

Recognition of Major Norman's activities came early in the war, and his services in developing aerial gunnery were of great value. His efforts led to the simplification of sighting arrangements, and followed from a recognition of the limitations peculiar to fighting in the air.

We announce with much regret the death, on September 6, of Mr. G. W. Walker, F.R.S., at the early age of forty-seven years.

The death is announced, on September 8, at the age of seventy-two years, of the Rev. J. B. Lock, senior fellow and bursar of Gonville and Caius College, Cambridge, the author of many well-known school books of mathematics.

We regret to learn of the death, on August 24, of Dr. J. A. Allen, for thirty-seven years a member of the staff of the American Museum of Natural History, New York.

The death took place on September 11, at the age of seventy-one, of Mr. R. E. Baynes, senior student of Christ Church, Oxford, and Lee's reader in physics.

Notes.

THE Edinburgh meeting of the British Association has been successful beyond even the most sanguine anticipations. The membership has reached nearly 2800, and all the sections have been largely attended, particularly during the joint discussions. These have, indeed, been so attractive that apparently the future practical problem will be to find sufficient halls large enough to accommodate the members who wish to be present at them. It is much more easy to provide meeting-places for a number of small sections than several large halls each of which will hold 400 people or so for a joint discussion. The success of the present meeting is largely due to the untiring devotion of Prof. J. H. Ashworth, whose intimate knowledge of the work of the Association made him an ideal local secretary. Sir Edward Thorpe's temporary indisposition, which prevented him from reading his address in person, was much regretted; but we are glad to know that Sir Edward is expected to be about again in a day or two. Next year's meeting at Hull will begin on September 6, and the president will be Prof. C. S. Sherrington, president of the Royal Society. The annual meeting in 1923 will be in Liverpool, and that in 1924 will probably be held at Toronto. The new members of the council of the Association are Dr. F. W. Aston, Prof. H. J. Fleure, Sir Joseph Petavel, Prof. A. W. Porter, and Prof. A. C. Seward.

A GENERAL discussion on "Catalysis, with Special Reference to Newer Theories of Chemical Action," will be held under the auspices of the Faraday Society on Wednesday, September 28, at the Institution of Electrical Engineers, Victoria Embankment, W.C.2. The discussion will be divided into two parts. Part 1, beginning at 4.30 p.m., will deal with "The Radiation Theory of Chemical Action," and it will be opened by Prof. J. Perrin. Part 2 will be concerned with "Heterogeneous Reactions." It will be opened by Prof. I. Langmuir. Among those expected to take part in the proceedings are Prof. Arrhenius, Prof. V. Henri, Prof. E. C. C. Baly, Prof. F. G. Donnan, Prof. W. C. McC. Lewis, Prof. A. Lindemann, Prof. A. W. Porter, and Dr. E. K. Rideal. Fellows of the Chemical Society are invited to attend the meeting. Others interested in the subject may obtain tickets of admission from the secretary of the Faraday Society, 10 Essex Street, London, W.C.2.

THE annual meeting of the British Mycological Society will be held at Worcester on September 19–24. On September 21 Mr. Carleton Rea will deliver his presidential address entitled "A Brief Review." On September 22 a discussion will be opened by Dr. E. J. Butler on "The Amateur in Relation to British Mycology," and a paper read by Prof. A. H. R. Buller on "The Chemo-taxis of Slugs in Relation to Fungi." On September 23 a paper will be read by Mr. J. Ramsbottom on "The Origin of Saprophytism in Flowering Plants."

THE Ministry of Agriculture and Fisheries announces that the Official Seed Testing Station for England and Wales has been transferred from Streatham to the National Institute of Agricultural Botany, Cambridge, and that all communications should in future be addressed to the Chief Officer, Official Seed Testing Station, Huntingdon Road, Cambridge.

IN the August issue of the *Journal of Hellenic Studies* Mr. F. N. Pryce describes a remarkable Minoan bronze statuette in the British Museum. The earliest date to which it has been traced is 1885, when it was included in the category of "unclassified or suspect bronzes," but it may possibly have entered the museum a hundred or a hundred and fifty years ago. Only quite recently its significance and value have been realised by comparison with other specimens of Minoan art. The height of the statuette, including the base on which it stands, is 8¾ in. The dress, by comparison with an Egyptian representation of a Minoan envoy on the tomb of Rekhmara at Thebes, belongs clearly to that period. The remarkable feature in the statuette is that instead of the middle hair lock it seems to bear the figure of a snake, which associates it with the Minoan snake cult. The worshipper—for the figure does not represent a deity—is apparently standing in an attitude of stiff reverence before the shrine of the goddess, with whom he enters into communion by wearing her emblem.

IN the August issue of *Discovery* Miss W. S. Blackman gives an account of the mourning rites of Musulmans in the province of Asyut, Egypt. Every Friday women, sometimes accompanied by their male relatives, visit this desert graveyard, wail at the graves, and distribute large basketfuls of bread. Curiously enough, Lane in his admirable account of death rites in his "Modern Egyptians" does not describe this rite, well known in other places, as in India, under the name of Ziyārat, or "visitation." It is obviously a survival of the animistic rite of feeding the dead. The rite, which has been handed down from the ancient Egyptians, is known as Prt, "coming forth" or "going up," and the reproduction which Miss Blackman publishes of an ancient Egyptian painting representing a woman wailing by the tomb of a dead relative closely resembles the photographs which she gives of the custom as it is carried out in modern Egypt.

DURING excavations made at Middleton-on-the-Wolds recently in connection with a whiting works there, a square grave cut into the chalk, which measured 3 ft. each way, was found, and adjoining it a long **V**-shaped trench. The owner, Mr. E. B. Lotherington, communicated with Mr. T. Sheppard, of the Hull Museum, and the trench was carefully excavated. The grave contained a human skeleton in a crouched position, on one arm of which was an iron bracelet carrying two large bone beads. In the same grave was a massive bone ring made from the thick part of an antler of a red deer. This measures 2¼ in. across and is remarkably well made, resembling the familiar ivory rings from Africa. Pottery found

in association with the burial consists of typical grey-ware turned on a wheel, and the rough hand-made dark pottery made from the Kimeridge clay, containing white fragments of grit, etc. The trench yielded numerous pieces of pottery, a part of a red deer antler pick which had been cut by a metal instrument, and bones of horse, ox, pig, sheep, and dog. The remains point to the hill upon which they were found having been occupied by the Romans in the second or third century. The trench excavated was only one of a number visible. The objects excavated have been placed in the museum at Hull.

WITH reference to the Note in NATURE (August 18) describing a catalogue of specimens of tapa or bark-cloth recently acquired by the Pennsylvania University Museum, Mr. Chas. J. A. Howes writes from 36 Havelock Road, Earlham Road, Norwich, that he possesses a copy of this rare work, but the title-page seems to differ in some particulars from that of the Pennsylvania copy. In Mr. Howes's copy specimen No. 18 is described as "the very finest of the inner coat of the mulberry wore (*sic*) by the chiefs of Otaheite." The collector notes, regarding this specimen, that some seamen were sent to fetch fresh provisions, and one of them met some children at play. One of them, a girl, snatched at the red feathers which he had stuck in his cap. He at once took them out and presented them to her. In the evening she came to the shore, and, singling him out from his companions, gave him the piece of cloth from which this specimen was cut—"a true sign of gratitude in these people."

IN a short article contributed to the Memoirs of the Manchester Literary and Philosophical Society (vol. 64, part 2) Major Leonard Munn discusses the ancient mines and megaliths in the Hyderabad State. The writer attempts to cover too much ground in a short paper, but he gives some interesting information. In corroboration of Prof. Elliot Smith's theories, he finds the stone monuments closely connected with ancient gold-mines, but of many of these the sites are now forgotten. Enough remains to show the perseverance and intelligence of the early miners. "Unless anyone has visited Hyderabad State, or, in fact, Southern India, they cannot form any idea of the abundance, the extent, or the pureness of its iron-ores. No section of the geological sequence exists in which iron does not occur."

THE Gold Coast Survey Department, which appears to have been suspended during the war, was re-opened in the latter part of 1919. The annual report for 1920 by the Surveyor-General, Lt.-Col. R. H. Rowe, has now been published, and shows much progress in the Department. The principal work was the completion of the topographical survey of the Colony, of which several sheets have already been produced on a scale of 1 : 125,000. During the year an area of 1200 square miles was surveyed. It is hoped shortly to undertake the reproduction of the sheets in the Colony, and buildings are being erected for this purpose. A school for the instruction of native surveyors was to be opened this year.

THE Geological Survey has just issued vol. 17 of the Special Reports on the Mineral Resources of Great Britain, the present volume being issued under the auspices of the Scottish Branch of the Survey. In this volume an account is given of the occurrence of the ores of lead, zinc, copper, and nickel in Scotland, the bulk of the work having been done by Mr. G. V. Wilson, whilst Dr. J. S. Flett, now Director of the Survey, has written the chapters on Caithness and on the Orkney and Shetland Islands. The work is exceedingly well done, and shows much painstaking study and research. It brings out, however, only too clearly the unfortunate fact that from the economic point of view the occurrences of these ores in Scotland are practically negligible. The only ore which occurs in any noteworthy quantity is that of lead, and this is due to one single mining district, for as such Wanlockhead and Leadhills may fairly be regarded, though the former lies in Dumfriesshire and the latter in the adjoining portion of Lanarkshire. During the period 1850–1920 the total production of lead from Scottish mines was 180,271 tons, of which the mining area above-mentioned contributed no fewer than 172,000 tons, the production from each group of mines being about equal. Similarly, the largest annual output of lead from Wanlockhead is given as 2578 tons and from Leadhills as 2600 tons, whilst no other mine in Scotland has reached an annual output of 400 tons. The present report is, therefore, more interesting from the geological than from the economic aspect, and Mr. Wilson has devoted much attention to the mode of origin of the deposits and to the vein-fillings. A considerable number of the minerals present are secondary in nature, and reasons are given for considering that the reactions causing secondary solution and deposition of certain of the ores are probably still in operation. It is to be regretted that the scope of this report was not somewhat widened so as to include all metalliferous minerals (with the exception of the ores of iron, which have already been fully discussed). This could have been done without adding much either to the labour involved or to the bulk of the report, and it would have been convenient to have had the occurrences of gold, for example, properly classified and fully described instead of finding merely casual references to its occurrence.

THE *Weekly Weather Report* of the Meteorological Office for the week ending August 27 gives a summary of temperature, rainfall, and sunshine for the summer season obtained from the values for the thirteen weeks from May 29 to August 27 for the several districts in the British Isles. The highest mean temperature for the summer in any district was 62·1° F. at the English Channel stations, and the second highest was 61·5° for South-East England. The mean temperature was above the normal in all districts with the exception of North and East Scotland, the greatest excess being 2·3° F. in the Midland Counties. The rainfall was decidedly less than normal except in West Scotland. The least total rainfall for the summer season was 2·04 in. for South-East England, which is 3·98 in. less than the thirty-

five-year normal and only 34 per cent. of the average. The next smallest total was 2·20 in. for East England, which is 4·06 in. less than the normal and 35 per cent. of the average. At the English Channel stations the total was 3·83 in., which is 2·52 in. less than the normal and 60 per cent. of the average. Bright sunshine was in excess of normal in all districts except North Scotland, the greatest amount of the possible duration being 53 per cent. at the English Channel stations, followed by 47 per cent. in South-East England and 46 per cent. in South-West England. The Greenwich values for the civil day published in the weekly returns of the Registrar-General give the average temperature, mean of maximum and minimum, 64·2° F. for the three summer months combined, the respective means being June 60·3° F., July 68·5° F., and August 63·8° F. The excess on the average for thirty-five years for the whole summer is 2·2° F., for June 0·4° F., for July 5·0° F., and for August 1·2° F. The rainfall for the three summer months combined was 1·29 in., the total for June being 0·46 in., that of July 0·15 in., and that of August 0·68 in. The deficiency for the summer on the average for 100 years is 5·42 in., and the total is only 19 per cent. of the average. Smaller falls have occurred previously in each month, but only once in July, in 1825, when 0·10 in. fell. The fall for the whole summer is the smallest in the last 105 years, the next lowest being 1·36 in. during the summer of 1818, followed by 2·50 in. for 1864. The sunshine for the three summer months at Greenwich registered 222 hours in June, 286 hours in July, and 179 hours in August, in all 687 hours, which is 92 hours in excess of the normal for the summer season.

CHARTS showing the deviation of the pressure and temperature from normal values for each month and for the year 1910, based on observations at land stations—generally two for each 10° square of latitude and longitude—have just been published by the Meteorological Office under the title of "Réseau Mondial, 1910." The charts have been prepared to illustrate the tables which were issued in 1920, and a similar volume of charts for 1911 was published in 1916. The late war has rendered it difficult at present to obtain data for the later years. This world-wide meteorology will add much to our present knowledge of weather changes, which in many respects are exceedingly intricate; it is by such world-wide information that we may eventually hope to forecast for longer periods than is possible at present, and in time, perhaps, we may foresee the character of a coming season. Atmospheric-pressure lines of equal deviation from normal are given for each five millibars, and for temperature the individual deviations are plotted for each station. In this volume it has not been found possible to represent graphically the deviation of rainfall from normal. Among many other questions of interest, such charts may render it possible to form some idea as to whether the pressure of the atmosphere is always practically uniform over the world as a whole; the charts in question would seem to suggest that it is, but a more detailed examination must be made to substantiate such a conclusion.

THE September issue of the *Philosophical Magazine* contains a paper on "The Effect of Temperature on the Rigidity and Viscosity of Metals" by Messrs. Kei Iokibe and Sukeaki Sakai, of the University of Sendai, Japan, which appeared in vol. 10 of the Science Reports of that University. The method used by the authors is that of torsional oscillations of a wire 25 cm. long and 0·6 to 0·7 mm. diameter suspended vertically in a tube furnace electrically heated to 700°–800° C. In all the thirteen metals tested as the temperature rises the rigidity decreases, according to a parabolic law which would make the value zero at the melting point. The decrease at low temperatures is small for metals with high melting points, but becomes rapid near the melting points in all cases. The viscosity as determined on Honda's theory from the logarithmic decrement of the oscillation increases rapidly as the temperature rises up to the melting point, but in the case of metals with high melting points there is a range of temperature below 100° C. within which the viscosity decreases slightly with rise of temperature.

IN a note on p. 502 of NATURE for June 16 we directed attention to the conclusion of Mr. T. L. Eckersley that the main source of the trouble in the determination of the direction from which a radio message comes during the night is the wave reflected downwards at the under-surface of an outer conducting layer of the atmosphere. In the August issue of the *Radio Review* Messrs. G. M. Wright and S. B. Smith, of the Marconi Research Department, describe observations on the night behaviour of the heart-shaped polar diagram obtained by combining a single frame with a vertical aerial, and find that it agrees with the reflected-wave theory. It shows further that the reflected ray is in a vertical plane and that its angle of incidence is small. In these circumstances the minimum of the heart-shaped diagram gives the correct bearing of the transmitting station, whether night disturbances are present or not.

THE paper on the magnetic electron which Prof. A. H. Compton, of the University of St. Louis, contributed to the American Association for the Advancement of Science in December last is reproduced in the August issue of the Journal of the Franklin Institute. After pointing out that Langevin's theory of diamagnetism is inadequate quantitatively and makes diamagnetism transient instead of permanent, Prof. Compton shows that the evidence is in favour of the negative electric charge being the prime cause of the magnetic property of the molecule. His own observations on the passage of X-rays through, and their reflection from, magnetised crystals show no evidence of the orientation of the molecules by the magnetic field, which present theories of magnetisation postulate. He considers that the electron spinning about an axis through itself like a small gyrostat is more likely to be the ultimate magnetic particle than either the atom or the molecule, and thinks that the spiral form of path which is so

frequent in the case of cathode or β-rays in air supports his view.

A FURTHER contribution to the study of the African rift valleys and their world-relations will be issued shortly by Messrs. Seeley Service and Co., Ltd., in a new work by Prof. J. W. Gregory, entitled "The Geology and Rift Valleys of East Africa." Its object is to show the continuity of the rift valley from Palestine to south of the Zambesi, with the exception of a short gap in the southern part of the Tanganyika territory. The work also summarises the volcanic history of East Africa, and shows that the rift valleys have been formed by a series of earth movements connected with the foundering of the Indian Ocean. These movements began in the Cretaceous, and have lasted until quite recent times. Some movements in connection with them are probably still in progress.

THE new list of forthcoming books just issued by Messrs. Methuen and Co., Ltd., contains a number of works relating to the subject of relativity, viz.:—"Space—Time—Matter," Prof. H. Weyl, translated by H. L. Brose; "Einstein the Searcher: His Work Explained from Dialogues with Einstein," A. Moszkowski, translated by H. L. Brose; "An Introduction to the Theory of Relativity," L. Bolton; "Relativity and the Universe," Dr. H. Schmidt, translated by Dr. K. Wichmann; "The Ideas of Einstein's Theory," Prof. J. H. Thirring; "Relativity and Gravitation," by various writers, edited by J. M. Bird; and "The Fourth Dimension Simply Explained," a collection of essays selected from those submitted in the *Scientific American's* prize contest, with an introduction and editorial notes by Prof. H. P. Manning.

Our Astronomical Column.

THE BRIGHT OBJECT OF AUGUST 7.—*Astr. Nach.* No. 5118 contains a further observation of this object made at Plauen, Vogtland, by the daughter of Prof. E. Kaiser and several others. It appeared like Venus at its greatest brilliancy, low in the evening sky shortly after sunset. Its position with regard to distant terrestrial objects was accurately noted. At G.M.T. 7h. 35m. its azimuth was 98° 22·6′ from south to west, and its apparent altitude 2° 35·9′; or 2° 21·9′ corrected for refraction. Plauen is in N. lat. 50° 29′ 45″, long. E. Greenwich 12° 7′ 11″; Prof. M. Wolf deduces that the R.A. of the body was 11h. 6·7m., N. decl. 7° 9′. This gives longitude 165·0°, N. lat. 1° 20′. It may be mentioned that the place of Jupiter was R.A. 11h. 23·9 m., N. decl. 5° 6′, but it does not seem possible that this could have been the body observed.

The Lick Observatory position at G.M.T. 15h. was about R.A. 9h. 22m., N. decl. 15·8°, or longitude 138°, N. lat. 0·4°.

It is to be noted that the object observed in England was much closer to the sun (estimates of distance 6° and 4° respectively) than the Plauen object, so that an element of doubt remains. But the latter observation was made in a much more exact manner, so it deserves greater weight. If we assume the identity of the Plauen and Lick objects, and that the motion was parabolic, then the maximum distance from the earth on August 7 was 0·005 in astronomical units, or about twice the moon's distance. It appears unlikely that a comet at this small distance would have such a well-defined stellar appearance.

EINSTEIN'S REAL ACHIEVEMENT.—The *Fortnightly Review* for September contains an article with the above title by Sir Oliver Lodge, in which he alludes to the awakening of interest in relativity brought about by Einstein's visit to England and the publication of Lord Haldane's book, which extends the doctrine to a wider field than that of kinematics.

Sir Oliver Lodge notes that the more ardent relativists treat the subject from a purely geometrical point of view, and endeavour to eliminate all reference to physical laws. For example, they suggest that the speed of a falling apple may be equally well attributed to the earth, and that the diurnal rotational movement may be ascribed to the heavenly bodies themselves. They minimise their references to the æther, some of them denying its existence. He deprecates these methods of treatment as unlikely to lead to advance in our knowledge of the universe. For his own part he expresses an ardent belief in the reality of the æther and its association with electricity and matter. He gives a brief *résumé* of the work of Clerk Maxwell (extended by Larmor, Lorentz, and Thomson), referring in particular to the relation connecting the electrostatic and electromagnetic units with the velocity of light, and passing on to the Lorentz-FitzGerald contraction, which plays an important part in the equations of relativity.

He urges the retention of the Newtonian conception of force in celestial mechanics, the simple law of inverse squares being amplified by the addition of the terms arising from the change of inertia with motion. He expresses his admiration at the skill which has succeeded in reducing the action of forces to formulæ in pure geometry; nevertheless, he considers that one is thereby introducing complexity and departing from the realities of Nature. However, throughout the article there is nothing but praise for Einstein's achievements, and criticism is merely directed against the method of expressing them.

NEBULAR LINES IN SPECTRUM OF R AQUARII.—The detection of the bright nebular lines at 4363, 4471 (helium), 4658, 4959, and 5007 superposed on the Md spectrum of this star was announced in 1919 by Mr. Paul Merrill, who gives an account in the *Astrophys. Journ.* for June of his further researches on the spectrum. Four spectra are reproduced, three of which were taken about a month before maximum (magnitude 8·3 to 7·0), and the fourth forty-seven days after minimum (magnitude 10·2). The first three show a continuous spectrum with the customary lines and bands of the Md type, together with the five bright lines. The fourth shows the bright lines quite as strongly as at maximum, but there is no trace in the reproduction of a continuous spectrum, and it is noted that it was practically absent even with considerably longer exposures.

There is also a comparison of the displacements of the two spectra on the plates taken near maximum. The Md bright lines give −33 km./sec., Md absorption lines −19, nebular lines except 4363 −10, and 4363 nebular −25. A statistical investigation on the stars of Md spectrum is being undertaken in the hope of determining whether the bright lines or the absorption ones, or neither, give the correct radial velocity. Many of them, including Mira Ceti, give the same relative displacement of about 14 km./sec.

Mr. Merrill suspects that the appearance of the nebular lines in the spectrum of R Aquarii may have taken place quite recently. He has examined the Harvard objective-prism spectrograms (dating from 1893). These lines are not observable on them.

British Roses and Hybridity.

THE genus Rosa, along with the brambles (Rubus), hawkweeds (Hieracium), and certain other polymorphic genera, has long furnished serious problems to the systematic botanist. Darwin spoke of the kind of variability which these genera show as "independent of the conditions of life," meaning that the differences exhibited are "of no service or disservice to the species," and are therefore not directly subject to natural selection. Modern geneticists would largely agree with that point of view.

In two recent papers (*Annals of Botany*, vol. 35, p. 159, and Trans. Nat. Hist. Soc. Northumberland, Durham, and Newcastle, vol. 5, part 2) Dr. Harrison and Miss Blackburn have thrown a great deal of light on the polymorphic condition which has long puzzled students of British roses. Their results are based on a careful study of the roses of northern England in the field and a cytological investigation of their chromosomes. This type of combined cytological and experimental investigation has already elucidated the nature of the variability in such genera as Œnothera and Drosophila, and its application to other groups is probably the most promising field in present-day genetics.

Contrary to the early studies of Strasburger, the fundamental haploid number of chromosomes in the genus Rosa is found to be seven. In *Rosa arvensis* and related forms the diploid (2×) number of chromosomes is fourteen. These forms show normal fertilisation, and the meiotic divisions are free from irregularities. The group of forms to which *R. pimpinellifolia*, L., belongs is tetraploid, the somatic number of chromosomes being twenty-eight (4×). In these forms also the meiotic divisions are for the most part normal, and fertilisation is necessary. These two groups of roses form a parallel to the diploid and tetraploid types in species of Œnothera, and since tetraploidy is known to have originated by mutation in Œnothera, it has probably originated in the same manner in the roses. The group of roses known as Villosæ is also tetraploid, but that these roses have originated in another way, probably as hybrids, is shown by the behaviour of their chromosomes, for instead of forming fourteen pairs in the reduction division there are seven pairs and fourteen single chromosomes.

Perhaps the most interesting are the pentaploid (5×) roses, of which four groups are recognised, containing such species as *R. sylvestris*, *R. rubiginosa*, and *R. coriifolia*. These have thirty-five somatic chromosomes and twenty-eight in the reduction division. Of the latter bodies seven are pairs or bivalents and twenty-one singles or univalents, thus making up the full number. The bivalents are almost invariably arranged in a central group surrounded by the univalents. These pentaploid roses have probably all originated through crossing, as is indicated by the behaviour of their chromosomes, among other things. The reduction divisions following this manner of chromosome pairing show the familiar irregularities in the distribution of their chromosomes, with the result that the pollen is almost wholly sterile. Dr. Harrison has also shown experimentally that these forms will set seed apogamously, although producing fertilised seeds in the same flower. The presence of apomixis, of course, accounts for these roses coming true from seeds.

The diploid roses and the Pimpinellifoliæ, which are sexual, are, on the contrary, looked upon as pure species. In accordance with the views of Ernst in a book on apogamy, published during the war, the presence of apogamy is regarded as a result of the stimulus of hybridity to vegetative development. The authors would explain the origin of many British hybrid roses of this type through northern forms belonging to the Afzelianæ clashing with the southern Eucaninæ, owing to climatic changes occurring perhaps at the beginning of the Glacial period. Other hybrids are probably being formed even now, and since the Afzelianæ are themselves pentaploid (5×) they must be the product of still earlier crossing. Thus it seems clear that a large proportion of our rose species are ancient hybrids the characters of which are perpetuated by apomictic reproduction.

Mr. J. R. Matthews (*New Phytol.*, 1920, p. 153) has also made a systematic study of British rose hybrids, and Miss Co'e (*Bot. Gazette*, 1917) has examined the pollen of American roses.

These and similar results obtained in recent years raise several important questions. The first is, of course, the part played by crossing in connection with evolution. The most extreme views on this subject have probably been held by Lotsy and Jeffrey. Both agree in believing that hybridisation occurs practically throughout the Angiosperms. The former, however, would attempt to explain all evolution as the result of crossing, while the latter holds that hybridisation and hybrid forms can have played no part whatever in evolution. In this connection it seems well to remember that in open-pollinated plants the evolutionary unit will be a group of interbreeding forms differing from each other in various characters, the differences being perpetuated by the crosses between individuals which are made each year. Crossing between related forms is then a condition under which evolution has taken place not only in open-pollinated plants, but also in animals. It does not necessarily follow, however, that crossing is the *cause* of that evolution. Dr. Harrison and Miss Blackburn conclude that "hybridity is one of the prime factors in the evolution of species," if not the only one. Their own results with the tetraploid (4×) roses of the group Pimpinellifoliæ, however, indicate that after the tetraploidy originated (whether through the stimulus resulting from crossing or not), germinal changes, *i.e.* mutations, must have occurred, giving rise to the present group of tetraploid forms. Again, the occurrence in various rose species of microgenes differing from each other in having full green or glaucous foliage, glabrous or hairy leaves, etc., can probably be best interpreted as the result of what we now call parallel mutations rather than indicating orthogenesis, as Dr. Harrison suggests.

Viewing these and related facts as a whole, it seems clear that while mutation and crossing are almost inextricably intermingled in the history of many plant genera, yet it does not follow that crossing is the cause of mutation. Even if this were the case, they should still be regarded as separate phenomena. It is a curious fact that in Drosophila, where the sexes are separate and crossing of individuals must therefore take place in every generation, no one seems to have tried seriously to explain the mutations as a phenomenon merely of hybridisation. This is probably because the evidence appears strong that many of these mutations had their germinal origin at about the time they appeared as external characters, *i.e.* in the immediately preceding generation of germ-cells.

Another point of general interest in this connection relates to the pollen sterility of hybrids. Jeffrey and his pupils have claimed that the presence of "bad pollen" is a proof of hybridity. This is the revival of a much older view, and studies of the pollen of Epilobium, Œnothera, Rubus, and other genera have been cited in support of this contention. Some of the results have been severely criticised by systematists,

who have shown that in certain cases only one species exists in a region where the presence of bad pollen is supposed to have proved hybridisation. Messrs. Brainerd and Peitersen have made a study of the New England Rubi (Vermont Agric. Expt. Sta. Bull. No. 217), in the course of which they find much hybridisation and no forms with entirely good pollen; they are therefore inclined to accept this dictum. That "bad pollen" is unsafe as a criterion of hybridity is shown, however, by other results. For example, Profs. Gates and Goodspeed (*Science*, 1916, p. 859), examining the pollen of various Californian species, found a variable proportion of bad pollen in *Trillium giganteum*, the nearest relative of which is in the Eastern States; *Dirca occidentalis*, the only other species being in eastern North America; and *Scoliopus Bigelovii*, a remarkably isolated genus of Liliaceæ, the only other species of the genus occurring much farther north.

That sterility or fertility of pollen is an inherited character has been shown in the sweet pea by Bateson and in the velvet bean (Schizolobium) by Belling, and it is reasonable to conclude that the occurrence of bad pollen may result not only from crossing, but also from mutation and from physiological or environmental conditions.

Geography in Austria.

By Prof. Grenville A. J. Cole, F.R.S.

THE Geographical Society of Vienna continued its octavo *Mitteilungen* througnout the war-years, though the style *kaiserliche königliche* perforce disappeared from its title with the issue of No. 12 in November, 1918. Few contributions could be expected from Austrian travellers in unusual fields, but the reviews of current exploration in all parts of the globe have kept the members up to date. The editors in 1914 were Drs. Fritz Machatschek and Hermann Leiter. The former became sole editor for 1915, and the latter acted from 1916 onwards. One naturally looks at first for special studies arising out of war-conditions. As early as October, 1914, Oberstleutnant Josef Paldus (vol. 57, p. 395) reviewed the system on which maps are grouped in the Kriegsarchiv in Vienna. This collection is rich in materials for students of history, and is by no means restricted to maps that will help modern armies in the field. It originated in an official military library formed by Prince Eugene of Savoy, whose frequent crossings of the Alps, and campaigns from Douai to Belgrade, must have impressed him deeply with the value of cartography. The kindly autocrat Joseph II. organised a detailed survey of the Austrian lands, remarking that to rule well required an accurate knowledge of the country. So long as he lived the collection of geographical material was carried on in a most liberal spirit. The position of Austria soon caused its military cartography to extend over adjacent lands, and Viennese maps are still our best authorities for a large part of the Balkan States. The sheets of the beautiful map of central Europe, on the scale of 1 : 200,000, which are frequently revised, are, moreover, among the best aids to travellers in southern Germany, northern Italy, Bosnia, and Poland. Oberstleutnant Paldus gives the date of inception of this series as 1907; but the Szombáthely sheet was issued in 1897, and the present writer used many others in road-journeys between Vienna and Sarajevo in 1899. The previous 1 : 300,000 map, remarkable in its time, seems to have escaped mention.

During the recent war Austrian observers were able to penetrate Albania from the north. Baron Nopcsa (vol. 59, p. 520, 1916) has utilised his collection of maps for an interesting summary of cartography in the region, beginning with the coast of "Dyrrachio" about A.D. 250. The paper is illustrated by numerous drawings from maps of the Cattaro-Dulcigno district, coming down to 1914. Eugen Oberhummer (vol. 61, p. 313, 1918) describes a journey with other members of an intelligence-bureau during the occupation of Montenegro and Albania. He directs attention to the map of Serbia, 1 : 75,000, completed by that State in 1888; this was repeated, from 1897 onwards, by an Austrian edition, in which the names are in Roman characters. Albania remained unsurveyed; Baron Nopcsa looked forward to the publication of Austrian work done during the war. Meanwhile, many things have happened, and the region has again eluded the embrace of an interested group of nations. Oberst Hubert Ginzl (vol. 61, p. 497) illustrates, by reproductions from the older sheets and the coloured and contoured new editions, the immense improvements made in the maps of Serbia and Albania under the stress of war. The older issues might guide troops along the highways, but were found useless for tactical dispositions. E. Nowak (vol. 62, p. 211, 1919) describes progress made by the war-geologists eastward from Durazzo and Valona. One wishes that peaceful international relations could ensure the completion of the good work thus begun.

In vol. 61, pp. 609–40, and vol. 62, pp. 25–40 (1919), six authors discuss, from various points of view, morphological, climatic, faunistic, and anthropological, how far natural boundaries can be assigned to Poland as marked out by the peace-terms. H. Praesent, in the anthropogeographical article, points out how the boundary between different types and grades of culture strikes the eye as one enters Poland—at Illowo, for instance—in the absence of any morphological feature. Even Galicia, with the glorious city of Krakow as a centre, has hung behind from a material point of view. The matter is not entirely due to political conditions. Anyone who knows the village inns, as compared even with those of Hungary, will agree that Praesent's observation is not inspired by race sentiment. Indeed, such sentiment as is allowed within the walls of the Geographical Society of Vienna seems directed towards a distant and hypothetical England, figuring as a corsair on the seas.

Anthropologists, such as Josef Weninger (vol. 61, p. 143, 1918), took advantage of the prisoners' camps to study unfamiliar folk. The Georgians are especially complimented on their understanding and on their sympathy with the spirit of research.

Among historical studies Hans. von Voltelini (vol. 59, p. 181, 1916) gives a valuable account of the origin of the southern boundaries of Austria before the war, which, of course, serves to rectify some current judgments. There are, for instance, writers who forget that Trieste escaped in 1382 from warfare with Venice to the security of Habsburg rule, and remained under this "domination" for more than five hundred years. The Austrians, however, did not become long-distance seamen until the sixteenth century. Prof. Eduard Zenker contributes papers on the Roman roads of Austria. "Karnuntum—Vindobona" (vol. 60, p. 507, 1917) reminds us of how Rome is still remem-

bered. We halted one golden evening at the little inn of Petronell, and praised the wholesome quiet of the spot. "Yes," replied the ostler, "Marcus Aurelius loved it well." It was not until the next morning that we saw the ruins of Carnuntum by the road.

As an example of European study we may note that Fritz Machatschek (vol. 60, pp. 235 and 274) describes the southern flanks of the Erzgebirge. This chain must no longer be regarded as an Armorican anticlinal ridge, but has been determined by successive bulgings of the floor from Lower Oligocene times onwards. Terrace-regions on the south represent portions of the main gently curved surface that have been lowered by faulting, and the well known volcanoes that produce such variety in the landscape are manifestations of earth-movements that continued into the Quartary (Quaternary) era. The evidence of such movements is seen in the stages by which the Eger Valley has been deepened. To turn to farther fields, economists and politicians will find much of interest in H. Leiter's review (vol. 62, pp. 414 and 433, 1919) of the present railway-system of Africa. The unfinished Cape-to-Cairo route now offers few attractions in view of the proposed cross-cut from Bukama, its present terminus, to the Congo mouth, a point quickly reached by sea from England. The numerous recent developments from the coasts of the Mediterranean, the Red Sea, and the Indian Ocean are described, and the dry details soon link themselves together as a romance. "Un tourbillon de sable," we once said to our guide, looking south over the Sahara, where a cloud rose among the dunes. "Pardon, monsieur," he replied, "c'est le chemin de fer." The railway was going forward to Touggourt.

The comprehensive paper by C. Diener on "Die Groszformen der Erdoberfläche" (vol. 58, p. 329, 1915) concludes that continental blocks and ocean-basins have shown permanence, at any rate since Permian times. Such work takes us into wider fields than Eugen Oberhummer's interesting discussion of imperialistic policies (vol. 63, p. 101, 1920) or H. Hassinger's well reasoned attempt to define the boundaries and the qualities of a Middle European region (vol. 60, p. 437, 1917). Both these essays in political geography provide much food for thought, and Hassinger's remark on the mixture of races between the Straits of Dover and the Black Sea is worth quoting: "Reiner Nationalstaat und Panslawismus sind Mitteleuropa fremd und wirken hier unnatürlich."

More illustrations are needed for papers dealing with natural features; but this defect must not be charged against those who have done their best to advance knowledge through the war-time.

Valence.

IN an article on "Types of Valence" in *Science* for July 22 Dr. Irving Langmuir develops still further the views on this subject which are associated with his name. He points out that the term "valence" has been used to describe (1) *positive valence*, or the number of electrons an atom can give up; (2) *negative valence*, or the number of electrons an atom can take up; and (3) *covalence*, or the number of electrons an atom can share with its neighbours. He brackets the first two under the name of "electrovalence," and accounts for them by the tendency to form a *complete layer* of 2, 8, 8, 18, 18, or 32 electrons (First postulate). The outer *incomplete* layer of electronegative elements, such as oxygen and the halogens, which tend to take up electrons, is distinguished as a *sheath*, and this term is used even when the atom has taken up electrons, so that the outer layer has become for the time a *completed sheath* in the negatively charged ion. The same term is also used in the case of the electropositive elements to describe the small excess of electrons which are lost when the atom becomes a positively charged ion.

The simplest complete layer consists of two electrons (*e.g.* in He or H^+) in close proximity to a nucleus; such a pair of electrons is called a *duplet*, and this term is extended to include any pair of electrons which is rendered stable by its proximity to one or more positive charges. The third type of valence is then controlled by the second postulate that "two atoms may be coupled together by one or more duplets held in common by the completed sheaths of the atoms."

Since each duplet eliminates two electrons as compared with those required to form a pair of complete sheaths, it follows that the algebraic sum of the electrovalences and covalences for all the atoms in any *complete compound* (*i.e.* a compound in which the sheaths of all the atoms are complete) is zero. Complete compounds without covalence include NaCl, $BaBr_2$, K_2S; MgO, BN, Al_2O_3; AlF_3, PCl_5, SF_6, etc. In these last compounds the halogens have seven electrons on the sheath of the atom, and therefore an excess of seven positive charges on the "kernel" (*i.e.* the atom *minus* the sheath), which creates a very strong attraction and enables these atoms to drag away as many as five electrons from an atom of phosphorus and six from an atom of sulphur. When no positive atom is present the electrovalence of every atom must be negative; no atom can lose electrons, and only covalence can exist. In this case the ordinary use of structural formulæ is legitimate; when electrons are transferred instead of being shared it is not. Since the sheaths of atoms of atomic number less than about 25 never contain more than eight electrons, the covalence of these atoms can never exceed four. With heavier atoms larger covalences may occur occasionally, *e.g.* in $Ni(CO)_4$, $Fe(CO)_5$, and $Mo(CO)_6$ the number of atoms in the sheath of the metallic atom is 10, 8, and 6, or 8, 10, and 12 less than the number required to make a complete sheath of 18 electrons. We therefore have negative valences of 8, 10, and 12, as indicated by the formulæ of the three carbonyls.

Incomplete compounds, containing atoms with incomplete sheaths, are particularly abundant in intermetallic compounds where only electropositive atoms are present, each with a sheath very far from complete. Thus in the two long periods 18 electrons are needed to complete the sheath, whilst, as a rule, only 4 can be lost (maximum positive valency equals 4) in order to remove it; there are therefore 14 elements which are compelled to retain electrons in the outer layer, and very few of these can complete their sheaths. These elements are, therefore, exclusively metallic in character, and even their compounds with electronegative elements usually contain loose electrons in incomplete sheaths and often exhibit metallic conductivity. The small and irregular positive valences of the transition-elements of the two long periods depend on the fact that their sheaths contain from 5 to 13 electrons, of which, as a rule, only 2, 3, or 4 can be detached to make a kathion.

The article is ingenious and suggestive, and represents a distinct advance in the process of explaining why and how combination between atoms takes place.

T. M. L.

University and Educational Intelligence.

BIRMINGHAM.—Under the will of the late Mr. Morton, of Moseley (who, in response to the University's appeal for funds, gave 10,000*l.* last year), a sum of 2000*l.* is left to the University for the foundation of scholarships.

The *Birmingham Post* of September 10 publishes a letter from the Vice-Chancellor (Sir Gilbert Barling), the Principal (Mr. C. Grant Robertson), and the Dean of the Faculty of Medicine (Mr. W. F. Haslam) to the Board of Management of the Birmingham General Hospital, in which is pointed out the serious effect on the clinical teaching of the students of medicine which will arise from the closing of two wards of the hospital. In a sympathetic reply the Board states that it is with the greatest reluctance that the wards have been closed, but the failure of voluntary contributions to meet the increase in cost of upkeep of the hospital has left no alternative. It is much to be desired that the public will realise the seriousness of the situation and that the necessary funds may be forthcoming to enable the wards to be reopened.

GLASGOW.—Mr. S. Horwood Tucker has been appointed to the lectureship in organic chemistry.

LONDON.—The programme of University extension lectures for the coming session has just been issued. Courses of lectures will be given and classes held at about seventy local centres in different parts of London and the surrounding district. The subjects treated cover a wide range, and lectures in the departments of literature, history, science, art, architecture, and economics are included in the list. Amongst the courses is a series of lectures on "Some Problems of Modern Biology," to be delivered by Dr. W. B. Brierley at Gresham College.

MR. R. M. C. GUNN, of Montrose, has been appointed lecturer in veterinary anatomy and surgery in the University of Sydney.

IT is announced in *Science* of August 26 that by the will of the late Frances Appleton Foster, of Weston, Massachusetts, the Massachusetts Institute of Technology will receive the sum of one million dollars and Wellesley College, Massachusetts, half a million dollars.

LEEDS UNIVERSITY has issued as a small pamphlet a prospectus of evening courses in technology which will be available at the University during the coming academic year. In the departments of civil, mechanical, and electrical engineering advanced courses extending over four or five years are provided; they are intended to meet the requirements of the examinations for membership of the Institutions of Civil, Mechanical, and Electrical Engineers respectively. A four years' course on coal-mining, designed to enable miners to qualify for managers' certificates, and special courses on dyeing and leather manufacture will also be given. An interesting feature of the pamphlet is the section dealing with "Courses Qualifying for Research Work and Trade Investigations." Lectures and demonstrations will be arranged with the idea of training students in the methods of research adopted in the textile industries, and, as a general rule, only students over twenty-two years of age will be admitted.

IN the prospectus for the session 1921–22 of the Technical College, Bradford, full particulars are given of the courses of instruction which will be given during the coming year. Three- or four-year courses leading to the college diplomas are provided in the departments of textile industries, chemistry, dyeing, and civil, mechanical, and electrical engineering. All these courses have been modified so that students for college diplomas may now present themselves for degree examinations at London University. Part-time courses, consisting chiefly of evening work, will also be given in the various departments. These lectures are provided principally in order to meet the needs of students who are employed in technical industries during the greater part of their time. Research work can also be undertaken at the college, and it is anticipated that when the new engineering laboratories, in which accommodation will be provided for heat treatment, metallography, oxy-acetylene and electric welding, etc., are available, this side of the activities of the college will receive a big impetus.

A USEFUL idea which has been adopted by Battersea Polytechnic is to issue an abridged calendar of the afternoon and evening classes provided during the coming session. It consists of 18 pages, but in that small space the authorities have contrived to indicate the subjects which will be dealt with, the lengths of the various courses, and, in many cases, a time-table of the lectures. A brief account of the full-time day courses is also given. Full instruction in preparation for London University examinations in science and engineering is provided in both day and evening classes, while there are also day courses in mechanical, civil, and electrical engineering, chemistry, physics, and sanitary science which lead to the college diplomas in the various subjects. Evening courses of similar scope are also to be given. In addition, special courses for honours students in chemistry have been arranged; Dr. F. W. Aston will lecture on atomic weights and isotopes, Dr. S. S. Zilva on enzyme chemistry, Mr. Greenberg on the microscopy of foods and drugs, and Mr. A. R. Pearson on the technology of fuels. Research by students of post-graduate standing is permitted only when the accommodation required is not such as to interfere with the routine work of the polytechnic. The pamphlet can be obtained free of charge on application to the Principal, Battersea Polytechnic, London, S.W.11.

THE sixteenth report (for the year 1919–20) of Leeds University, which has recently been published, provides a brief but interesting account of the many activities of the University, together with some interesting figures relating to the cost of University education. Taking the University as a whole, the cost per student for the past year was about 75*l.* This figure is less than that for the year 1913–14 by some 7*l.* The fall in the cost is accounted for by the fact that the number of students has greatly increased, while the salaries of the professorial staff, as we have said repeatedly in these columns, shows but a relatively small increase. However, of this 75*l.* the average fee paid by the student is 27*l.*, leaving some 48*l.* per head to be found by the University. An analysis of the total income available for 1920–21 reveals the fact that 36·1 per cent. was provided by students' fees, 32·7 per cent. by Government grants, 16·4 per cent. by grants from local education authorities, and 14·8 per cent. by endowments, subscriptions, etc. The most noteworthy gift was a sum of 4000*l.* from the Clothworkers' Company of London, which brings the total of that company's list of benefactions to the University to no less than 77,250*l.* Some valuable plant and machinery have also been presented by various engineering firms. The officials responsible for the finance of the University are to be congratulated on the fact that, in spite of building new lecture-rooms and laboratories and making other costly extensions, the University will enter upon the year 1921–22 without a deficit in its accounts.

Calendar of Scientific Pioneers.

September 15, 1883. Joseph Antoine Ferdinand Plateau died.—A valuable contributor to physiological optics and molecular physics, Plateau was trained under Quetelet, and from 1835 to 1871 held the chair of physics at Ghent. From 1843 he was totally blind.

September 16, 1736. Gabriel Daniel Fahrenheit died.—German by birth, Fahrenheit became an instrument-maker at Amsterdam. His improvements in thermometers consisted in the use of mercury, the introduction of the Fahrenheit scale, and the substitution of elongated bulbs for round ones.

September 16, 1869. Thomas Graham died.—Distinguished mainly for his investigations in physical chemistry, Graham from 1837 to 1855 held the chair of chemistry in University College, London, and was the first president of the Chemical Society. He discovered the law of the diffusion of gases, and to him we owe the terms "crystalloid," "colloid," "dialysis," and "atmolysis."

September 17, 1783. Leonhard Euler died.—Though born in Basle and trained in mathematics by Jean Bernoulli, Euler passed most of his life at St. Petersburg and Berlin. One of the greatest mathematicians and physicists of the eighteenth century, his works have been described as a perfect storehouse of investigations on every branch of algebraical and mechanical science.

September 17, 1836. Antoine Laurent de Jussieu died.—Carefully trained in medicine and botany by his uncle Bernard, de Jussieu in 1789 published his "Genera Plantarum," a volume which formed the basis of modern botanical classification. The Musée d'Histoire Naturelle was reorganised by him in 1793.

September 17, 1877. William Henry Fox Talbot died.—A graduate of Trinity College, Cambridge, Talbot from 1822 contributed scientific papers to the Royal Society, but is most famous for his pioneering work in photography. He was the first to produce positives from negatives, and invented the "Calotype" process. His apparatus has recently been given to the Royal Photographic Society, and it is proposed to set up a memorial to him at Laycock Abbey, Wiltshire.

September 18, 1896. Armand Hippolyte Louis Fizeau died.—An early worker on photography, Fizeau also made many investigations on light and heat, and in 1849 determined the velocity of light by measuring the time it took to travel between Suresnes and Montmartre, a distance of 28,334 ft. He was awarded the Rumford medal in 1866, and from 1878 was a member of the Bureau des Longitudes.

September 19, 1710. Ole Römer died.—The discoverer of the finite velocity of light, Römer was born in Jutland, became a pupil of Erasmus Bartholin, worked with Picard, and spent the years 1672 to 1681 in Paris. He made known his great discoveries to the Paris Academy of Sciences in 1675. Returning to Copenhagen as a professor of mathematics and astronomy, he there set up the first modern transit instrument. Practically all his manuscripts and instruments were destroyed by fire in 1728.

September 19, 1761. Pieter van Musschenbroek died.—A well-known Dutch experimental philosopher, Musschenbroek held chairs at Duisburg, Utrecht, and Leyden, and added greatly to the knowledge of the physical properties of bodies.

September 21, 1576. Girolamo Cardano died.—One of the most interesting figures connected with the revival of science in Europe, Cardano was a physician, astrologer, and mathematician, and held positions at Pavia, Milan, and Bologna. His chief mathematical work is his "Ars Magna," published at Nuremberg in 1545. E. C. S.

Societies and Academies.

PARIS.

Academy of Sciences, August 29.—M. Léon Guignard in the chair.—M. **de Séguier**: The primitive quaternary group of collineations of order 25920 and the Hessian group.—J. **Chazy**: Curves defined by differential equations of the second order.—S. **Carrus**: Triple orthogonal systems.—G. **Bertrand**: Newton's law and Einstein's formula for the perihelion of the planets.—L. **Gentil**: The phenomenon of mounds (*rideaux*) and solifluction. These mounds are frequent in the region between the Somme and the Bresle, and have been attributed by the author to superficial slipping of siliceous clay softened by rain. The *frane* of R. Almagia and the *solifluction* of J. G. Anderson are considered as particular cases of a phenomenon which in France leads to the formation of *rideaux*.—E. **Zaepffel**: Mobile starch and geotropism. It was proved experimentally that in an apparatus containing the substances present in the plant-cell (water, amylase, sugars, and starch) the concentration of the sugar became unequal, with a maximum in the immediate neighbourhood of the starch grains. In the plant-cell, with the starch grains resting on the semi-permeable protoplasmic membrane, this change of concentration in sugar causes modifications in the osmotic relations between the different cells which explain the movements of the tissues.—J. **Pottier**: Observations on the chromatic masses of the cytoplasm of the oosphere in *Mnium undulatum* and *M. punctatum*.—W. **Koskowski** and E. **Maigre**: The peripheral origin of the hyperthermia produced by methylene-blue.—W. **Kopaczewski**: Surface tension and the suppression of shock by sodium hyposulphite. Details of experiments proving that sodium hyposulphite reduces the increase of surface tension caused by the addition of distilled water to serum.—G. **Bourguignon**: Modification of the chronaxy of the motor nerves and muscles by reflex repercussion.

SYDNEY.

Linnean Society of New South Wales, July 27.—Mr. G. A. Waterhouse, president, in the chair.—Dr. R. J. **Tillyard**: Mesozoic insects of Queensland. No. 8. Hemiptera Homoptera (continued). The genus Mesogereon, with a discussion of its relationship with the Jurassic Palæontinidæ. Additional material comprising three forewings and fragments of two hindwings has been found. In addition to the single species of Mesogereon already known, four species are described as new. It is concluded that Handlirsch was wrong in considering the Palæontinidæ to belong to the Lepidoptera, and that the general build of the insects, the venational scheme, the armature of the wing, and the structures of the margin show that the Palæontinidæ are closely related to the genus Mesogereon, and that both have a less close connection with the recent Cicadidæ.—G. D. **Osborne** and W. R. **Browne**: Note on a glacially striated pavement in the Kuttung series of the Maitland District. The striated pavement described provides evidence of the presence of land-ice which previously had been indicated solely by the presence of glacial conglomerates and varves. The direction of the striæ is N. 13° W.–S. 13° E., the ice having moved in a northerly direction. The floor over which the ice moved is composed of a biotite-dacite, and is overlain by well-laminated varve-rock.—T. **Steel**: The occurrence of calcium oxalate in the Gidgee wattle, *Acacia Cambagei*. The bark of this tree contains 18·8 per cent. (dry) of calcium oxalate, the highest amount recorded for any plant. The timber contained an average of 1·77 per cent. The barks of a number of other species of Acacia were

found to contain from 1·36 to 8·92 per cent. of oxalate, thus resembling the Eucalypts.—G. F. **Hill**: *Coptotermes Raffrayi*, Wasman (fam. Termitidæ). This Termit was described in 1900 from specimens of the soldier caste. From the examination of a nest series of imagines, soldiers, and workers and two series of soldiers and workers the validity of Wasman's species is now definitely established.

Books Received.

Relativity and the Universe: A Popular Introduction into Einstein's Theory of Space and Time. By Dr. H. Schmidt. Authorised translation by Dr. Karl Wichmann. Pp. xiii+136. (London: Methuen and Co., Ltd.) 5*s*. net.

All About Pets: Told in Stories. By Lilian Gask. Pp. 224. (London and Sydney: G. G. Harrap and Co., Ltd.) 6*s*. net.

Joe Strong: The Boy Wizard. By Vance Barnum. Pp. 189. (London and Sydney: G. G. Harrap and Co., Ltd.) 3*s*. 6*d*. net.

Records of the Botanical Survey of India. Vol. 6, No. 9. Useful Plants of the District of Lakhimpur in Assam. By H. G. Carter and D. N. Carter. Pp. 353–420+ix. (Calcutta.) 1 rupee.

The Carnegie Foundation for the Advancement of Teaching. Bulletin No. 15. Training for the Public Profession of the Law. Historical Development and Principal Contemporary Problems of Legal Education in the United States, with some Account of Conditions in England and Canada. By A. Z. Reed. Pp. xviii+498. (New York City.)

Results of Meteorological Observations in the Five Years 1916–20 made at the Radcliffe Observatory, Oxford, under the Direction of Dr. A. A. Rambaut. Vol. 52. Pp. xiii+115. (Oxford: Humphrey Milford; London: Oxford University Press.)

Memoirs of the Geological Survey. Special Reports on the Mineral Resources of Great Britain. Vol. 19. Lead and Zinc Ores in the Carboniferous Rocks of North Wales. By B. Smith. Pp. iv+162+3 plates. 5*s*. 6*d*. net. Vol. 21. Lead, Silver-Lead, and Zinc Ores of Cornwall, Devon, and Somerset. By H. Dewey. Pp. iv+72. 2*s*. 6*d*. net. (Southampton: Ordnance Survey Office; London: E. Stanford, Ltd.)

Aggregation and Flow of Solids: Being the Records of an Experimental Study of the Micro-structure and Physical Properties of Solids in Various States of Aggregation, 1900–21. By Sir George Beilby. Pp. xv+256+34 plates. (London: Macmillan and Co., Ltd.) 20*s*. net.

Edinburgh's Place in Scientific Progress. Prepared for the Edinburgh Meeting of the British Association by the Local Editorial Committee. Pp. xvi+263. (Edinburgh and London: W. and R. Chambers, Ltd.) 6*s*. net.

Handbuch der biologischen Arbeitsmethoden. Abt. xi., Methoden zur Erforschung der Leistungen des Pflanzenorganismus. Teil 2, Heft i., Lieferung 13: Spezielle Methoden a/Pflanze. Pp. 186. 54 marks. Abt. v., Methoden zum Studium der Funktionen der Einzelnen Organe des Tierischen Organismus. Teil 3, Heft i., Lieferung 18: Entwicklungsmechanik. Pp. 218. 66 marks. Teil 3, Heft ii., Lieferung 33: Entwicklungsmechanik. Pp. 219–440. 72 marks. (Berlin und Wien: Urban und Schwarzenberg.)

Aus dem Archiv der Deutschen Seewarte. XXXVIII. Jahrgang, 1920, Nr. 6. Strömungen und Oberflächentemperaturen im Golfe von Guinea. By Dr. J. Janke. Pp. 68+7 tafeln. (Hamburg: Hammerich und Lesser.)

Department of Scientific and Industrial Research. Report of the Food Investigation Board for the Year 1920. Pp. 39. (London: H.M. Stationery Office.) 1*s*. net.

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Transactions of the Royal Society of Edinburgh. Vol. 52, part 4 (No. 32). On Old Red Sandstone Plants, showing Structure, from the Rhynie Chert Bed, Aberdeenshire. Part 4: Restorations of the Vascular Cryptogams, and Discussion of their Bearing on the General Morphology of the Pteridophyta and the Origin of the Organisation of Land Plants. By Dr. R. Kidston and Dr. W. H. Lang. Pp. 831–54+5 plates. (Edinburgh: R. Grant and Son; London: Williams and Norgate.) 6*s*. 6*d*.

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CONTENTS.

	PAGE
Cholera Risks	73
The Human Factor. By J. D.	74
History of Science in Edinburgh	75
An Electronic Theory of Valency. By J. B. C.	77
Along the Snow-line of Peru	78
Our Bookshelf	79
Letters to the Editor:—	
Uniform Motion in the Æther.—E. H. Synge; Dr. Harold Jeffreys	80
Relation of the Hydrogen-ion Concentration of the Soil to Plant Distribution.—Dr. W. R. G. Atkins	80
"Smoky" Quartz.—Prof. C. V. Raman	81
Brown Bast and the Rubber Plant.—G. Bryce; The Writer of the Note	81
The Nature of Vowel Sounds.—Preston Edwards; Prof. E. W. Scripture	82
The Generation of Heath-fires.—Henry Bury	83
Life and Mind.—Sesamy	83
The Stream of Life. By Prof. Arthur Dendy, F.R.S.	84
Speech through the Æther. By Sir Oliver Lodge, F.R.S.	88
Variations of Climate since the Ice Age. (*Illustrated.*) By C. E. P. Brooks	90
Obituary:—	
Henry Woodward	93
Notes	95
Our Astronomical Column:—	
The Bright Object of August 7	98
Einstein's Real Achievement	98
Nebular Lines in Spectrum of R Aquarii	98
British Roses and Hybridity	99
Geography in Austria. By Prof. Grenville A. J. Cole, F.R.S.	100
Valence. By T. M. L.	101
University and Educational Intelligence	102
Calendar of Scientific Pioneers	103
Societies and Academies	103
Books Received	104

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Causes of Fluctuations in the Birth-rate.

IT is not surprising, in view of the fundamental importance of population, that the declining birth-rate, which began in England in 1876 (in France much earlier), and has now become general in most civilised countries having accurate records, has been the subject of numerous studies. At first crude birth-rates stated per 1000 of the total population were regarded as sufficing for these studies. They did so when all that was desired was to show the effect of births on the increase in population. These birth-rates, however, failed to indicate the true fertility of the population. Child-bearing in women practically occurs only between the ages fifteen and forty-five: it varies greatly in married couples, according to the proportion of married women living at different ages within these thirty years of life, and according to the duration of marriage. The age of the father has been found, in actual experience, to have an almost negligible influence.

There have been two major studies in which the subject has been investigated and correction made for these arithmetical causes of variation, one by Newsholme and Stevenson, which appeared in the Journal of the Statistical Society in 1906, and another by Mr. Udny Yule, published at the same time in the same journal. The results of these investigations are summarised in an interesting paper now before us.[1]

The facts show that the decline in the birth-rate is due chiefly to a fall in the productivity of married couples, and that this fall has been proceeding at an accelerating rate. They show also that there are great differences in the birth-rate in various social strata, and it is likely that the decline in fertility has been greatest in the professional and upper classes. It has, however, been great in many artisan circles, and especially in the textile districts.

What is the interpretation of these facts? Mr. Yule disagrees with Dr. Stevenson, of the General Register Office, in his view that the decline in fertility of married women is "due to the increasing practice of contraceptive measures." That such measures are largely practised, that they are becoming increasingly practised, that they are advocated by a large number of people who believe over-population to be the chief cause of poverty, that clinics for teaching married women contraceptive measures have been formed, and that a large mass of cheap literature on the subject is circulated, are all facts beyond dispute. The facts that the decline in the birth-rate has been greatest among the educated classes and least among agriculturists and miners, who would be less likely to be "made wise" on the subject, and that the beginning of the fall in the birth-rate corresponded in time with the Bradlaugh-Besant prosecution for publishing "The Fruits of Philosophy," undoubtedly support this view. But in Mr. Yule's opinion it is too simple an explanation; and he justly urges that even if these measures constitute the chief means for reducing fertility, they do not explain the almost universal desire for such reduction.

Is there any evidence of variations in fertility in circumstances in which contraceptive measures may be assumed not to have been in use? In some small group-inquiries this appears to have occurred, though the evidence is not conclusive. Mr. Yule's main point rests on the discovery of instances in which an increased birth-rate has occurred in circumstances in which the artificial prevention of conception in the period of lower birth-rate can be excluded. He produces a solitary instance, that of Connaught, the true fertility in which was 35 to 39 per cent. greater in 1911 than in 1881, and 6 per cent. greater in 1871 than in 1881. This being an almost purely Roman Catholic area, the use of contraceptives may probably be excluded. One may, however, doubt the accuracy of the birth statistics of this area. As pointed out in another part of Mr. Yule's paper, compulsory registra-

[1] "The Fall of the Birth-rate." A paper read before the Cambridge University Eugenics Society, May 20, 1920, by G. Udny Yule. Pp. 43. Cambridge: At the University Press, 1920. 4s. net.

tion of births was not enforced in England until 1875, and it is probable that for many years later both birth and death registration were imperfect and irregular in Ireland, especially in its remote parts.

It would be more satisfactory, as supporting natural changes in fertility, if other trustworthy instances could be quoted. True, Dr. Brownlee's figures for Geneva are quoted showing a decline of more than 40 per cent. in the birth-rate between the beginning of the eighteenth century and the early nineteenth century; but these figures, like some other international rates for prolonged periods, can scarcely be said to favour the view that fluctuations in the birth-rate (corrected for number of marriages and age at marriage) occur naturally. If they do occur naturally we must assume that they are physiological in character, being rhythmic variations in "germinal vitality" (Brownlee), which have been compared to the outbursts of infectivity, say, in the influenza organism, the cause of which is unknown to us, though we express our ignorance by using Sydenham's language of "epidemic influences." Mr. Yule sees no reason "why man should be exempt from analogous phenomena," but it is difficult to conceive any analogy between variations in activity of unicellular organisms and variations in sexual activity of a complex mammalian. Nor are we impressed by the suggestion of comparability of such phenomena as plagues of field-mice or plagues of locusts. These are more naturally explained on the supposition that an excessive death-rate has occurred among other creatures which would have maintained the balance of Nature; and it does not appear inappropriate to refer to the old puzzle as to the relationship between old maids, field-mice, bees, and the clover crop.

This last suggestion brings us to the most valuable section of Mr. Yule's paper. Whether contraceptive measures or other causes, not being arithmetical as explained above, have caused the reduced birth-rate, how is the birth-rate related to economic conditions? Mr. Yule is convinced that the course of prices is closely related to the trend of the marriage-rate and of fertility, though he states that he is at a loss to suggest the precise nature of the nexus. He regards the nexus as economic, probably acting *via* psychology rather than directly through physiology; and he does not believe that the nexus is wholly volitional, acting through contraceptive measures or otherwise. He regards migration, marriage-rate, and fertility as only three forms of response to demand for population.

There we must leave this momentous problem. It deserves even more study than it has hitherto received. That economic circumstances, raising the age for gainful employment and the like, have had marked influence in lowering the birth-rate is certain. That the desire for a higher standard of comfort and for a more satisfactory upbringing of a smaller family, not necessarily selfish, has been a potent factor is equally without doubt. Whether at the end of another generation the differential birth-rate will, as many fear, lower the standard of health and intelligence is doubtful. The present writer regards this fear as exaggerated. Talent emerges in all social strata; but where large families imply imperfectly nourished children and a deficiency of parental care, they must necessarily lower the average standard of health. Is this occurring for a larger proportion of the total population than in previous generations? Probably not.

Indian Land Mollusca.

The Fauna of British India, including Ceylon and Burma: Mollusca.—III. *Land Operculates. (Cyclophoridae, Truncatellidae, Assimineidae, Helicinidae.)* By G. K. Gude. Pp. xiv + 386. (London: Taylor and Francis; Calcutta: Thacker, Spink, and Co.; Bombay: Thacker and Co., Ltd., 1921.) 35*s*.

AMONG the Indian land mollusca the family Cyclophoridæ especially attracts attention by the beauty of form and variety in the shells. The range is extensive, and their study began so far back as 1849, when W. H. Benson, of the Bengal Civil Service, and Capt. T. Hutton were writing on the animal of Diplommatina. After seventy years the above families are still very imperfectly understood, so little is known of the animal which constructs the shell. I think I am correct in saying the time had not arrived for publishing a volume on these molluscs, for sufficient material had not been examined; in truth, much has yet to be collected. It would be interesting to know for this reason why Mr. Gude was selected to do it, and the work then left to all intents and purposes completely in his hands; why malacologists with knowledge of the subject were not consulted; and why the present writer, with more than forty years' connection with these land operculates, both in the field and in collections, was in complete

ignorance that such a work was under compilation. It leads me to think of past workers in this field of natural history. The foremost among them was the late Dr. William Blanford, the editor and founder of "The Fauna of British India." No one would have known better how much preliminary work there was to do, or what material to obtain; and had he lived he would have prepared the way for it, as he did for vol. 1 of the Mollusca Series (the Testacellidæ and Zonitidæ). It recalls the type of paper he wrote on the animals of Raphaulus, Spiraculum, and other tube-bearing Cyclostomacea so long ago as 1863 in "The Annals and Magazine of Natural History." There is even now food for thought in this paper, while it is an indication of how the history of the land operculates should be approached, which is to be looked for in vain in the publication under notice.

The shells of living species should no longer be treated as if they were fossils, the animal unobservable, unobtainable; this I notice under the genera Japonia, Cyclophorus, Alycœus, and Diplommatina, pp. 6, 57, 301, 304, and 349. This neglect of the animal in classification should not thus continue. It is not up to the standard of the present day, and some advance was to be looked for, based on more recent original investigation.

Space does not admit of quoting many and various errors, but looking at the contents I begin with "The Systematic Index" and naturally turn to the genera I am best acquainted with. On p. xii I have to notice, very fully, an unfortunate, inaccurate record of species under the sub-genus Raptomphalus of Alycœus; eight species are put into it, whereas it is represented by only one, *R. magnificus*, described by me in "Land and Freshwater Mollusca of India," vol. 2, part 12, p. 366, plate 156, figs. 1, 1*a*, 1*b*. These figures show that in shell character it is very different and distinct from typical species of Alycœus. As yet it has been found only in the Yamne Valley, a large tributary of the Tsangpo, which comes in on the left bank, not far from the base of the mountains, in the Abor country.

Mr. Gude has extended the range of this new sub-genus enormously. One of the eight is a species from the Shan-Siam frontier, 500 miles distant, where the sub-genus cannot certainly be expected to extend. All these eight Alycœi are very variable in form, unlike *R. magnificus*. A glance at the figures will show this. A place for each of them has now to be found in the index, and all on pp. 286, 287, 288, and 289 are out of place. On p. 285 *Raptomphalus magnificus* is not the "first species"; it should be "only species."

Such a record does not help zoology; it has gone forth to the world, striking directly at the accuracy of geographical distribution, and before it can be disproved it will be used, trusted, and quoted by workers, both at home and abroad, for years to come. The record in "The Mollusca of India" from the first has been geographical. I have been at pains to show how the distribution of species living in the great valleys of the Himalayan range changes as we proceed from west to east. This was to be expected, for these great valleys are geologically ancient, isolated one from the other, and separated by great physical features, especially in the Eastern Himalaya by snow-clad meridional ridges. In age these valleys are sufficiently old to be centres of "species development." We are able to state that there is scarcely a species living in the Teesta Valley of Sikkim common to the Tsangpo Valley and Abor Hills. The molluscan fauna of the Dafla Hills is remarkable in comparison with both the above areas. Here physical geography comes in to the support of distribution, and shows how accurate the record of the latter should be made. The former tells us that while the Teesta Valley and its neighbours on the west in Nipal, and on the east in Bhutan, have drained for ages into the great depression of the Bay of Bengal, it was comparatively a recent geological change when the Brahmaputra took the same course. Indeed, all evidence goes to show that the Tsangpo originally drained into Burma; it certainly did so all through the Siwalik period, to go no further back in time. It was the elevation of the Assam range, extending from Eastern Assam to the Garo Hills, which produced this wonderful change in geography over a vast area. In Eastern Assam the Tertiary sandstones, all derived from the waste of the Himalayas, are elevated to 10,000 ft. and above. This has had everything to say to the distribution of life, particularly the molluscan, both land and freshwater, in this part of India and the eastern frontier, and affected the spread of genera and species. It explains why the molluscan fauna of the Tsangpo Valley is so restricted, and why it cannot be found anywhere, as the distribution attributed to Raptomphalus might lead some zoologists to suppose.

On geological evidence we can presume to say that the Barowli, the Dikrang, and the Ranga of the Eastern Himalaya once flowed directly to the Kyandwen, and the Subansiri and the Tsangpo to the Hkampti Long and head waters of the Irrawady. It explains the finding of certain species

of Unio and Sphærium, both in Munipur and in Assam, and of the distribution of many other genera and species, including Austenia.

The volume adds very little to our previous knowledge of the land operculates of India. An opportunity has been lost of bringing that knowledge up to date. The money spent on it might have had a better result. There is an absence of editorial supervision. Mr. Guy A. K. Marshall is not mentioned in the preface; all seemingly devolved on Mr. G. K. Gude. It is purely conchological and was brought out in a hurry. It should not, in fact, have been commenced until it was first ascertained who were to be engaged upon it and what collections were available. This is most important to those who, at great expense of time and toil, collect material and desire to see it in the hands of the best malacologists and so far have a voice in the publication.

Next we have to consider the best place of publication, whether in this country or in India. I lean to the latter, for in India the animals of many genera could be collected in a few weeks as required and worked out by the staff of the Indian Museum, who are quite capable of doing so. I also consider it essential to accuracy in a record of this kind that the type shell of all species should be compared so far as possible to verify the "original descriptions" in the pages and pages of "copy" which fill the volume. This applies also to the figures given of species in the Natural History Museum and other collections. They are not typical; some have no history, and are not in all cases correctly identified.

The history of the Indian operculate land shells has yet to be compiled and a more scientific classification built up. For this reason I am disappointed with this volume of "The Fauna of British India," and imagine that among other zoologists there will be a similar feeling.

In the volume there is a mass of useful compilation, particularly in the synonymy, as well as in the bringing together of the many species in the four families treated of. This work, looked at from the purely conchological side, cannot fail to be useful to collectors.

H. H. GODWIN-AUSTEN.

Chemistry of Anthracene.

Anthracene and Anthraquinone. By E. de B. Barnett. Pp. xi+436. (London: Baillière, Tindall, and Cox, 1921.) 27*s.* 6*d.*

THE history of anthracene is long and vivid. Discovered amongst the products of coal-tar distillation in 1832, the hydrocarbon played a modest and somewhat commonplace part in the development of structural theory, suddenly blossoming into prominence in 1868, when it was found that alizarin, the twin monarch with indigo of natural colouring matters, is a dihydroxyanthraquinone. The persistent and active investigation of anthracene derivatives consequent on this revelation had scarcely slackened in 1901, when Bohn discovered the remarkable condensation undergone by β-aminoanthraquinone, leading to indanthrene and flavanthrene, vat-dyes superior in fastness to indigo itself. During the subsequent period notable additions to the series have been made in the direction of complex benzanthrones—for example, violanthrene, a non-nitrogenous vat-dye represented as an oxygenated agglomeration of nine benzenoid nuclei. Thus anthracene, now approaching its centenary, still provides abundant material for scientific investigation and practical application.

. It is, therefore, most appropriate that so much information, extending over so many years, should be assembled in a form convenient for reference, and the volume which Mr. Barnett has produced will be found extremely valuable by all chemists who desire to be advised of the latest discoveries in this important field. Beginning with a comprehensive survey of the early work and the substituted derivatives of anthracene itself, the author passes to anthraquinone, anthrone, and anthranol. Treatment of the numerous hydroxyanthraquinones has been limited to the ground which is not covered by A. G. Perkin and Everest in their recent book on "The Natural Organic Colouring Matters," and thus it has been possible to devote almost half the text to aminoanthraquinones and the highly important modern discoveries to which reference has been made. It is this feature which will be most appreciated by chemists because, owing to the recent developments of anthracene chemistry having taken place principally in the German dye-factories, the relevant information is largely scattered through the patent literature, and is consequently not easy of access.

Some idea of the faithful industry which the author has brought to his task may be gained from the statement that the index to German patents so liberally quoted throughout the volume alone occupies eighteen pages, and refers to more than one thousand items, which are assembled in sequence, with the respective date and name of patentee. Constant attention is directed to those colouring matters which arise from the various classes of anthracene derivatives, thus adding to the general usefulness of the book a quality speci-

ally attractive to chemists concerned with the application and manufacture of dyes.

Praise is due also for the general index, and, excepting a few lapses into laboratory slang and the "of course" habit, the literary form is commendable. In the second edition, however, it is to be hoped that the author will establish uniformity of construction in the compound words; to find "octa-chlor anthracene" in one line, and "tetrachloranthraquinone" in the next, is exasperating to a methodical reader, and a bad example to students. This fault is persisted in throughout, and is the only blemish in an otherwise admirable treatise. M. O. FORSTER.

The Future of Geometrical Optics.

(1) *Geometrical Investigation of the Formation of Images in Optical Instruments, embodying the Results of Scientific Researches conducted in German Optical Workshops.* Edited by M. von Rohr. (Forming vol. 1 of "The Theory of Optical Instruments.") Translated by R. Kanthack. Pp. xxiii+612. Printed and published for the Department of Scientific and Industrial Research by H.M. Stationery Office, 1920. (From any bookseller or through H.M.S.O. at Imperial House, Kingsway, W.C.2, and 28 Abingdon Street, S.W.1; 37 Peter Street, Manchester; 1 St. Andrew's Crescent, Cardiff; 23 Forth Street, Edinburgh; or from E. Ponsonby, Ltd., 116 Grafton Street, Dublin.) 2*l.* 5*s.* net.

(2) *Die Binokularen Instrumente: Nach Quellen und bis zum Ausgang von* 1910 *Bearbeitet.* By Prof. Moritz von Rohr. Zweite, Vermehrte, und Verbesserte Auflage. (Naturwissenschaftliche Monographien und Lehrbücher. Zweiter Band.) Pp. xvii+303. (Berlin: Julius Springer, 1920.) 40 marks.

AT a meeting of the Optical Society held in Cambridge on May 21 last, the future of geometrical optics formed the subject of an interesting discussion, in which the points of view of mathematicians and practical designers respectively were expressed. The subject has regained actuality in recent years in view of the undoubted superiority in optical design possessed by the German manufacturers in 1914, a superiority which proved a serious handicap to us in the manufacture of optical instruments such as range-finders, etc., required for military and naval purposes. The importance of this branch of knowledge was then realised; unfortunately, before the war the subject had been gradually dropping out of university curricula, the laborious algebra involved and the stereotyped methods of treatment combining to render it distasteful to mathematical teachers and students. Relegated to a corner of the mathematical syllabus, geometrical optics was too often reduced to a few formulæ crammed in a hurry, and it lacked the vitalising influence of really interesting and practical illustrations. The manufacturing optical designer, on the other hand, tired of waiting for mathematical developments adequate to his needs, became increasingly empirical in his methods, and even now depends almost exclusively upon trigonometrical tracing of a few rays, which is, in fact, nothing else but trial and error. Probably this almost complete divorce between theory and practice accounts largely for the unprogressive character of pre-war British optical design as compared with the German.

(1) It is a natural inference that in some way the British type of text-book on this branch of science fails to stimulate the reader, and, bearing in mind the pioneer work of Abbe, Seidel, Steinheil, Koenig, and von Rohr in Germany, it is obviously desirable that the work of these masters of the subject should be made readily accessible to English-speaking students. The Department of Scientific and Industrial Research is therefore to be congratulated upon bringing out a translation of the classical treatise on "The Theory of Optical Instruments," edited by Moritz von Rohr. The translation has been carried out by Mr. R. Kanthack, and the work has evidently been done with great conscientiousness and accuracy. The translator acknowledges the valuable help of Messrs. J. W. French and E. B. Knobel and of Prof. J. W. Nicholson. In various respects the translation is an improvement on the original, the numbering of the paragraphs and equations greatly facilitating reference. Additions and modifications have also been made to the bibliography, and the figures have been improved and various errors corrected. The book is well got up, and altogether a very creditable production, which meets an undoubted need.

When all this has been said, however, it may be doubted whether, after all, von Rohr's treatise is really likely to stimulate the student, at any rate in this country. For one thing, it is not the work of a single mind. Chap. 1, on the fundamental principles, is by H. Siedentopf; chap. 3, on Abbe's theory of optical images, by E. Wandersleb; chap. 4, which treats of optical images from a different point of view, by P. Culmann; chap. 8, on prisms, by F. Loewe; Dr. Koenig has written chaps. 6 (on chromatic aberrations) and 7 (on the computation of optical

systems in accordance with the theory of aberrations), the latter probably the most important of the whole book, from the point of view of the designer; von Rohr himself, although responsible for the editing of the entire collection, has actually written only chaps. 9 (on the theory of stops) and 10 (on the photometry of optical instruments); while he and Koenig are jointly responsible for chaps. 2 (on the computation of rays through an optical system) and 5 (on the theory of spherical aberration).

In the circumstances it is inevitable that there should be a certain lack of cohesion, which gives one the impression of a number of separate treatises bound together rather than of an ordered and progressive exposition.

To remedy this an attempt has been made to set up a rigorously uniform nomenclature throughout. A list of symbols is given at the end, but this list occupies six large pages of print, and the very sight of it seems likely to paralyse the reader. If symbols are to be standardised, then they should be as few and as fundamental as possible, so that they can be readily learnt and retained in the memory. This has the additional advantage of releasing a mass of symbols for use in special problems, where they may be usefully employed in simplifying the algebra.

Even with all these precautions the notation is not always clear; thus in formula (7), at the foot of p. 350, x' apparently refers (although this is not stated) to the intercept on the axis made by a principal image ray of a particular colour; but on the very next page x' is used to denote the intercept on the axis made by the image plane, and these two are not the same.

The suffix notation is based on refracting surfaces, quantities after refraction being accented. In many respects a notation which assigns odd suffixes to refracting surfaces (or to given combinations of them) and even suffixes to media is more convenient; it saves the use of accents, which are always confusing, making them available for other uses.

The main trouble, however, is that throughout the book the learner is not led up progressively from the easy to the difficult. Fundamental principles and results which must be grasped and remembered are not sufficiently extricated from a mass of detail which is best put on one side for reference if and when it is needed. Each chapter takes the reader to the limits of its particular domain, and leaves him there, somewhat bewildered at the multiplicity of results. What is really required in a mathematical subject of considerable algebraic complexity such as geometrical optics (or, say, theory of elasticity, or lunar theory) is a guiding thread, knotted at intervals into fundamental theorems. For such a guiding thread one looks in vain in von Rohr's treatise.

One notices, too, that characteristic tendency of most German works towards needless elaboration. Thus Fig. 15 and almost the whole of pp. 45 and 46 could be dispensed with by simply applying to the triangles BB_uO_u and BB_uO_u' in Fig. 14 the rule that the sides of a triangle are proportional to the sines of the opposite angles, which leads immediately to formula (6) of p. 46. Instead, we are given two pages of algebra, with several new symbols, including an auxiliary angle. This is only one of many examples.

On the other hand, the work is not free from the converse defect of introducing statements made on unconvincing grounds. Thus on p. 351 we are told that $V\beta=0$ when $s_k'=\infty$, because

$$\frac{Vs_k'}{s_k'-x_k'}=\frac{V\beta}{\beta}.$$

But in this case we have usually $\beta=\infty$ and $Vs_k'=\infty$, so a proof that $V\beta=0$ would involve a discussion of awkward indeterminate forms, of which nothing is said.

Such failures, however, are few. On the whole, the subject is treated with complete thoroughness, and the discussion is exhaustive, if laborious. von Rohr's theory of optical instruments is, and must remain, a classic and an admirable book of reference. But one must regretfully admit that the ideal book which is to fire the enthusiasm of the young British optical designer has still to be found.

(2) Far more attractive to the reader, and conceived in quite a different spirit, is another book by von Rohr, which appeared last year in Berlin, to wit, the second edition of his "Binocular Instruments." This is an eminently readable and interesting monograph dealing with the development of stereoscopic instruments, a branch of optical design in which German manufacturers had made very great progress before the war. The chapter dealing with the early investigations before the time of Wheatstone has been enlarged and rewritten.

The book opens with a chapter on the theory of stereoscopic vision, but the bulk of it is historical and descriptive, and the reader gradually builds up his knowledge of the subject by following the evolution of successive instruments. We would strongly recommend the study of this work to the British optical manufacturer. Its language is non-mathematical, and the geometrical arguments are easy to follow. The diagrams are not

elaborate (probably on account of post-war conditions), but they are sufficient. The whole subject is one of great interest. Stereoscopic instruments have now got well beyond the curious toy stage, and have many applications of precision, not the least of which is to range-finders, of which the Germans appear to have made considerable use.

The value of such a historical monograph, especially with the excellent index of names and references at the end, is very great. To anyone desirous of acquiring rapidly knowledge of a subject for research purposes, it means an incredible saving of time and labour. It is also an aid to research in another way, by unearthing a number of results long forgotten, from which many a valuable hint can be gleaned. For the lack of work of this kind far too much of the time of men of science nowadays is spent on rediscovery. L. N. G. F.

Kite Balloons.

The Design and Stability of Streamline Kite Balloons, with Useful Tables, Aeronautical and Mechanical Formulae. By Capt. P. H. Sumner. Pp. viii + 146. (London: Crosby Lockwood and Son, 1920.) 10*s.* 6*d.* net.

WHILE a vast literature has grown around aeroplanes since the outbreak of the war gave an unprecedented stimulus to aeronautical theory and practice, and a certain amount has been written about airships, very little indeed has seen the light of publication in connection with balloons. Popular interest was attracted to the more spectacular phases of flight; the Zeppelin raids dominated the minds of millions of non-combatants in the early part of the war, and the aeroplane raids captured their minds later on. To the active service man who was inclined to join the Air Force the aeroplane gave promise of excitement and distinction; to the scientific investigators at home the aeroplane and airship presented many problems of baffling difficulty and interest. The kite balloon, on the other hand, never reached such heights of popularity. Its work was more useful than spectacular; ever shrouded in secrecy, it scarcely ever attracted the attention of any who were not immediately engaged in its construction or its use.

A certain amount concerning the kite balloon is to be found in such a book as Bairstow's "Applied Aerodynamics," but it seems that Capt. Sumner's is the first separate book on the subject, at least in English. The author takes as model a balloon of capacity 670 cubic metres, which can rise to a height of 2500 ft. with one observer, and a suitable amount of ballast. By means of proportional rules other sizes can be readily calculated.

First the functions of the various parts of the kite balloon are explained, and then the aerodynamics are dealt with, leading up to the equilibrium problem. Longitudinal stability comes next, but the stability considered is statical, not dynamical; this ensures great simplification, of course, but something might have been said about the justification for using it. Chapters follow on the effect of the wind, tension in the material of the balloon, the valve, the envelope and rigging. There is, finally, a short account of meteorological balloons.

Much useful information is contained in the appendix, which is, however, rather miscellaneous in character. One wonders whether a man capable of following the reasoning in such a book needs an appendix containing the formula for the area of a circle or the definitions of the trigonometrical ratios. S. BRODETSKY.

Our Bookshelf.

Airman's International Dictionary: Including the Most Important Technical Terms of Aircraft Construction, English, French, Italian, German. By Mario Mele Dander. Pp. vii + 227. (London: Charles Griffin and Co., Ltd., n.d.) 6*s.*

AVIATION for commercial purposes has failed to develop in the manner that was anticipated, yet several regular air services have come into existence, and if the evolution of civil aeronautics is slow, we can have no reason to doubt the ultimate emergence of the aeroplane and airship as standard means of locomotion. There is therefore complete justification for the assertion in the publishers' note that ". . . there is urgent need for a handy dictionary which will enable a flying man to make his needs and desires known in whatever country he may land." The dictionary was printed in Italy, and Messrs. Griffin have secured copies for issue in this country. It forms an eminently useful handbook, not only for the pilot, but also for the student and researcher, who often have to consult literature in foreign languages and deal with terms which are too recent for the standard dictionaries.

The dictionary gives the important technical terms in connection with aeroplanes and airships, as well as with aeroplane and airship construction. There is a "one alphabet" index for all four languages, thus saving much time in the search for the meaning of any term.

In a book of this kind mistakes and misprints are to be expected, and it is to be hoped that in a future edition experts in the various languages will be called in to revise the terms. Thus any

English worker in aeronautics would have been able to supply the usual terms for "frontal resistance," "end of climb," "gigantic plane," etc.

S. BRODETSKY.

Handbook of Instructions for Collectors. Fourth edition. Pp. 222. (London: The British Museum (Natural History), 1921.) 5*s*.

THE present edition of this valuable little handbook contains several material alterations. Chapters have been added on the preparation of mammalian skeletons, with special notes on the collection of specimens of Cetacea, on the collecting and preservation of worms, and on alcohol and alcoholometers; while the chapters dealing with soft-bodied and other invertebrates, birds, reptiles, batrachians, fishes, and insects have been considerably modified. The trustees of the British Museum are well advised in issuing the handbook at a low price and in portable form (it measures 7 in. × 5 in. × ½ in.), for it constitutes an authoritative manual of instructions on the collecting and preservation of all objects included under the comprehensive title of "natural history." The hunter of big game is told how to skin his "kills" and to preserve the pelt and skeleton to the best advantage; indeed, collectors of every kind receive instructions enabling them to render their captures of real scientific value when brought home for detailed examination. The handbook should lie on the work-table of the curator of every museum, and be in the kit-bag of everyone who is prepared during his travels to preserve objects for the enrichment of our national or other public collections. There are very few curators who will not learn something of value to their museum from these pages; and probably none who have not at one time or other been compelled regretfully to scrap material presented because the well-meaning donor has not known how to collect intelligently or to preserve usefully. In future there need be no such mistakes.

Sun, Sand, and Somals: Leaves from the Notebook of a District Commissioner in British Somaliland. By Major H. Rayne. Pp. 223+12 plates. (London: H. F. and G. Witherby, 1921.) 12*s*. 6*d*. net.

THE conversational style and highly amusing nature of Major Rayne's lively book by no means obscure the light that it throws on the Somali character, particularly that side of it which could be observed only by one occupying an official position similar to that of the author and largely concerned with the administration of justice and the settlement of disputes in the patriarchal fashion alone understood by the Somalis. No less interesting are the narrative portions. The description of the trek to Hargeisa is so vivid that the reader almost imagines himself one of the party. The chapter that recounts the end of the Mad Mullah illustrates the universal law of history, that when the means of force are dispelled the end of the tyrant is inevitable. An error of date has slipped into p. 214: it was at the beginning of April, 1903, that Col. Plunkett and his force were ambushed, leaving as survivors only thirty-eight natives of the K.A.R.; Gough's action was on April 22, about a fortnight later. Since those days much more has been learned about Somaliland and its inhabitants, and it may be that the use of the word "Somals" as a collective noun for the various tribes, though not to be found in Swayne's standard work, is the modern convention.

Geology of the Non-Metallic Mineral Deposits other than Silicates. Vol. 1, *Principles of Salt Deposition.* By Amadeus W. Grabau. Pp. xvi+435. (New York and London: McGraw-Hill Book Co., Inc., 1920.) 30*s*.

GEOLOGISTS owe a debt of gratitude to Dr. Grabau for the preparation and publication of this volume. It is a mine of information on the occurrence and characters of deposits of mineral salts, exclusive of silicates.

The theories which have been advanced for their formation are fairly stated, and there are ample references to the literature of the subject. The author includes in his survey not only the salts of the halogens, but sulphates, nitrates, and phosphates, as well as certain elements, oxides, and hydrates associated with them. He acknowledges the sea as the great source of salt deposits, but is inclined to give rather undue importance to the salt enclosed in marine sediments in comparison with that transported by the wind. He terms the former "connate" salts, and the latter, not very happily, "cyclic" salts. Salts due to chemical changes *in situ* are termed "meta" salts, in spite of the fact that chemists have used the prefix in more than one other distinct sense. Naturally special attention has been given to American deposits, but the other continents are not neglected, though we have been unable to find any reference to the important "Magadi" soda lakes in East Africa. An interesting account is given of the "salt domes" in different parts of the world.

J. W. E.

Bibliographie des Séries Trigonométriques: Avec un Appendice sur le Calcul des Variations. By Maurice Lecat. Pp. viii+168. (Louvain: M. Lecat, 1921.)

A VERY considerable debt is owing to M. Lecat not only for the labour which has been put into the compilation of this most valuable bibliography, but also for undertaking the publication of it without the help of any subvention, especially at so difficult a time. The main list is in alphabetical order according to authors, and gives full bibliographical details. It appears to be remarkably complete and up to date. A second list gives the titles of all the periodicals quoted in the first. An appendix provides a supplement to a similar bibliography on the calculus of variations (published 1913–16), and refers mainly to items which have appeared in the last five years. Those who specialise in the subject of trigonometric series will find M. Lecat's work invaluable.

South African Mammals: A Short Manual for the Use of Field Naturalists, Sportsmen, and Travellers. By A. Haagner. Pp. xx+248. (London: H. F. and G. Witherby; Capetown: T. Maskew Miller, 1920.) 20*s.* net.

THERE is no lack of works on the subject of African mammals. Some of them are of a purely sporting character; others appeal more particularly to the naturalist; Mr. Haagner's book on South African mammals claims to be a short manual for the use of field naturalists, sportsmen, and travellers.

No other country of equal size possesses so large and so varied a mammalian fauna as South Africa, and it is quite a feat to describe all the species occurring there in so short a compass, and to illustrate the text with more than 140 photographic reproductions. Some of the latter no doubt might, with advantage, have been omitted, as they give but a poor idea of the animals alluded to, and this would have left a little more room for the text. Many of the illustrations, however, are good, particularly those of the zebras.

The author, as he says in his introduction, has purposely adopted a more or less "note-book" style, and this has resulted sometimes in rather loose and inadequate descriptions. For example, all the information he can give us about the small grey mongoose is that it is a small edition of the grey mongoose, and about the same size as the slender mongoose. All naturalists must disapprove of the actions of what Mr. Haagner justly styles "game-butchers." It is therefore all the more surprising that he should reproduce as a frontispiece to his book a photograph of a heap of skulls, referred to as the hunting trophies of the "good old days."

As we should expect, the book appeals more directly to managers of zoological gardens and to dealers in livestock. The author's unsuccessful experiences in endeavouring to rear the young of Cape hunting-dogs are shared by many others. Only the Dublin Gardens have been more fortunate in their efforts, and have contrived to breed and rear the pups.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Communism and Science.

IN view of the article on "The Proletarisation of Science in Russia" in NATURE of September 1, the following extracts from a letter I have just received from a well-known Russian professor of chemistry may be of interest. I have omitted personal references and a few other matters. J. W. MELLOR.

Pottery Laboratory, Stoke-on-Trent,
September 5.

"You doubtless know the old adage, 'Primo vivere, deinde philosophari.' I do this last, but the first part, 'vivere,' is more than uncertain for us who have the misfortune to be a little civilised, as one never knows what our wild, wild taskmasters are going to do next. The higher schools of Petrograd are under the control of a former apprentice of the dockyards of Cronstadt, who has learned to talk glibly and to sign his name with an appropriate flourish. He has not the remotest notions as to what is a seat of high learning; but that does not trouble him in the least, he just governs according to his lights, and actually does his best to destroy all culture, all real science, in our institutes. It is just the same everywhere, and the results are glaringly apparent in the utter failure of crops in the east and south of Russia, due not so much to exceptional climatic causes as to the countless requisitions of 'surplus' wheat, 'surplus' bullocks and horses, and other kindred measures of the reigning proletariat. The population of some twenty provinces, which supplied once upon a time almost all Russia with bread and exported thousands of tons of wheat to foreign lands, is now leaving their houses and fleeing to the east, the north, and the west of Russia, where there is still something to eat; they spread desolation wider and wider—also cholera and other diseases; tens of thousands perish daily. Almost nothing is left in the devastated provinces; they must now be colonised anew. We are fortunate for the nonce in being sufficiently far from these places, but the outlook for us is anything but reassuring.

"Up to now we receive a 'ration of scientists,' which during 1920 was comparatively good, but is now reduced to the following items, received, for instance, in June:—14 lb. of bread (made principally out of soya beans); 11 lb. of soya beans (it is not generally known that they contain poisonous constituents, and many were the cases of poisoning); 19 lb. of herrings; 4 lb. of tallow (the first fatty substance received since February); 9 lb. of wheat (we eat it boiled in the form of gruel); 3 lb. of macaroni made out of soya beans; 1 lb. of salt; 1¼ lb. of sugar; 3 lb. of lean pork—bones and hide, no lard, and very little meat; ¼ lb. of tea (surrogat); ¾ lb. of tobacco; some matches; and 1 lb. of washing soda (there is no soap). During the same month I received—only a few days ago—as salary for my lectures, etc., the stately sum of 21,000 roubles; but as bread costs about 4000 roubles and butter 30,000 roubles per lb., this sum is the equivalent of 5 lb. of bread, or some 20 kopeks (=5*d.*) of pre-war days. You will thus appreciate the munificence of my salary; the meanest mechanic or plumber gets from 250,000 to 500,000 roubles and more monthly, and it is nothing unusual to pay 1 lb. of bread or 5000 roubles for one hour of manual work, whereas I, as a full-fledged professor and doctor of chemistry, receive for one hour of lecture 450 roubles. Consequently, to nourish the members of the family (I have, fortunately, neither wife nor children, but live with my old mother), I work in kitchen-gardens, sell the few things that are still left, etc. The prices for a new suit range up to 1,000,000 roubles; a pair of old high boots, which I could not wear and which cost originally some fifteen years ago 14 roubles, fetches now 700,000 roubles, as boots are very scarce; for a shirt you get 2 lb. of butter. During the first six months of 1921 my mother and I have eaten different foods to the value of about 6,000,000 roubles.

"Needless to say that, in spite of these millions, we are now paupers in the strict sense of the word. All my savings, made little by little during more than twenty-five years of professorship, were placed in State loans and annulled in 1917; our small landed estate not far from Petrograd was taken from us in 1918, and is now completely devastated, all the woods having been cut. It would be now utterly impos-

sible to exist without the 'ration of scientists,' meagre as it is. I read in NATURE in 1920 a notice on the voyage of Mr. Wells to Petrograd and his opinion on the position of our men of science (NATURE, vol. 106, p. 352). He did not see much, as he was 'personally conducted,' and does not understand Russian. He estimates the number of men of science at four thousand; NATURE expresses some astonishment at this number—thinks there must be less, as many have died. Well, there is here an official commission, composed of Mr. Oldenburg and other learned gentlemen, who decide whether an applicant is a man of science or not. As it is often a question of life and death, the decision is usually in favour of the applicant, if certain formalities are fulfilled—if he has printed some learned articles, or even simply written one, etc. Professors are almost always included if they teach in higher schools. There are now very many proletariat "higher institutes"; for instance, a "Higher Institute of Anti-fire Technique" and a "Higher Institute of Plastic Arts"; the first turns out firemen for fire brigades, the second—dancers! "Professors" of these institutes are also "scientists"! Even among the professors of old high schools there are now some without scientific degrees called "red professors"; for now it is decreed that anybody can be a professor, just as anybody who is sixteen years of age can be a student. If he is quite ignorant he will attend a "preparatory course," but, like real students, will receive his ration and salary (students do not *pay* anything now, but receive salaries).

"Thus the question, 'What is a man of science?' is not so simple as it seems. The number of men of science would certainly exceed the four thousand of Mr. Wells if the Soviet of deputy workers and deputy red soldiers did not happen to fix the number of rations at two thousand. Of course, all this is very detrimental to the interests of real scientific workers, whose number, I should think, does not exceed several hundred; the more so as it is officially announced that scientific workers of England, France, and the U.S.A. have formed committees to help us. It would be a good thing if some representatives of these committees could come and preside over the distribution. Last year the Norwegian Government sent us a lot of presents, but the precise amount sent was carefully kept in the dark, so that we have more than a suspicion that we received only a part of the alms—and then only some coarser things, like herrings and cod—and that the dainties were taken by other parties for whom they were not intended.

"You see I write as a matter of course about receiving alms; we have long ago lost all sense of pride—beggars cannot be choosers—and we can only thankfully accept foreign help. As I express myself easily in English I could not resist the temptation to give to you just a very small epitome of what is meant by 'vivere' for us, but there are many other not very agreeable things which I cannot mention now. In spite of them, the habits of twenty-five years cannot be given up, and I still interest myself in the process of chemistry. . . .

"I have read over what I have written on the subject of 'primo vivere, deinde philosophari,' and see that there is enough unintentional humour about it—but there is precious little humour in living it through."

The Disaster to the Airship R38.

IN the article on "The Disaster to the Airship R38" in NATURE of September 1, the author laments that, in consequence of it, airship development is to be abandoned by our Government, and airship design is referred to as being a matter of experience and guessing. In face of the general tenor of the article, it may be of interest to direct attention to six letters published in *Engineering* in November and December, 1901, which I wrote in a discussion of the torpedo-boat destroyer *Cobra*. Those letters are as applicable to the R38 as to the *Cobra*.

Some eminent scientific men then denied the possibility of the disaster to the *Cobra* being due to gyroscopic action of the propeller and engines; and the first of my letters was written merely to insist on the existence of such action, though I declared that I could not consider it sufficient to account for such an accident. The course of the discussion, however, led me to declare it to have been the sole cause of the disaster.

The important point is that all then existing destroyers had engines fitted into them after the ship had been built. I pointed out that such engines should be built with the bearings as an intrinsic part of the engines and extending the full length and breadth of the ship, and also strong enough to resist any force that could be exerted by the engines. I considered that a vessel and engines so constructed would not only be safer, but might also be lighter than one dependent on heavy plates and girders for strength to stand the stresses created by pitching and rolling.

By giving the airship's engines such bearings as above suggested it may be made safe against any such accident as that which has wrecked the R38.

The old destroyers offered, perhaps, more scope for saving weight than the airship, but by giving such bearings to the engines as above suggested at least three-fourths of the present weight of girders might be dispensed with. WM. LEIGHTON JORDAN.

Royal Societies Club, September 3.

BEFORE dealing with the main contention of Dr. W. Leighton Jordan's remarks on the loss of R38, it is desirable to refer to the opening paragraph and to correct the impression that, "in consequence of it, airship development is to be abandoned by our Government." The policy of the Air Ministry was determined and announced many months before the accident, and therefore cannot have been influenced by the failure of R38. The campaign for economy in the public service, combined with a lack of enthusiasm on the part of the Air Council, is much more likely to be the explanation of the decision to abandon airships.

Dr. Jordan appears to attach much importance to gyroscopic action in relation to the breaking of R38. Such action is called into play when the airship turns, and, as is well known, the magnitude of the couple is proportional to the rate of turning of the ship. There is little difficulty in estimating the magnitudes of the forces to be resisted, and, since an airship turns slowly, in seeing that they are relatively small. It is not usual for engineering structures to fail against well known loads, and there is no reason to suppose that R38 is an exception. It is rather to those unknown effects supposed to be covered by a "factor of safety" that attention is drawn by failure. The less the scientific and technical preparation for construction, the greater the call on the allowance for ignorance. The scientific objection to full-scale tests to destruction is not to their effectiveness, but to their cost in life and material; they are, in fact, the result of false economy.

THE WRITER OF THE ARTICLE.

The British Association at Edinburgh.

A RETROSPECT.

FROM every point of view the visit of the British Association to Edinburgh has been an unqualified success. With the exception of the last day of the meeting the weather was highly favourable; and even on that day the rain was confined to the early forenoon hours. Every morning the reception room, the old Parliament Hall, was crowded with members whose eager happy looks showed that they were enjoying the meetings to the full. The citizens of Edinburgh gave themselves up to the spirit of scientific gaiety, and the visitors heartily responded. Every section had its own devoted band of disciples; and what specially impressed those who remembered the last Edinburgh meeting in 1892 was the proportionately greater number of women members. This, of course, added a brilliancy to the gatherings, particularly when two or more sections met for a common discussion.

These common discussions formed indeed one of the distinctive features of the Edinburgh meeting: physicists and chemists together inquiring into the structure of molecules; physicists, geologists, and biologists comparing views on the age of the earth; chemists and physiologists solving the mysteries of biochemistry; botanists and geologists discussing in lively fashion the oldest land flora; geographers and anthropologists striving to discover the origin of the Scottish people; geologists and engineers trying to come to an agreement on the Mid-Scotland canal; and so on in other cases. The popularity of these combined discussions was demonstrated by the crowded attendances which strained to the very utmost the accommodation provided by the largest classrooms of the university.

Fortunately for the presidential address and the various evening lectures and addresses splendid accommodation was afforded by the Usher Hall, which was completed just before the outbreak of the war. Owing to his regrettable illness Sir Edward Thorpe was unable to deliver his address in person, and it was not until the last day but one of the meeting that the members of the Association were able to rejoice in the presence of their president. The citizens of Edinburgh took full advantage of the special lectures prepared for them. Sir Oliver Lodge discoursed with his well known ease and lucidity on "The Principles of Wireless Telephony"; Prof. Dendy delighted a large audience with a finely-planned lecture on "The Stream of Life," and Prof. Fleure gave a suggestive and highly interesting disquisition on countries as personalities, in which special prominence was given to Scotland. The two evening discourses given to the members of the Association were both of great local interest, one being a comparison of the Forth and Quebec Bridges, by Prof. C. E. Inglis, O.B.E., and the other on "Edinburgh and Oceanography," by Prof. Herdman, C.B.E., F.R.S. Both lectures were profusely illustrated by lantern slides, and were greatly appreciated by large audiences.

The great reception given by the Lord Provost was held, as usual, in the Royal Scottish Museum, the large hall and galleries of which formed an appropriate setting for this large and brilliant gathering. Huge though the assembly was in point of numbers, there was no uncomfortable crowding. Endless streams of friendly groups meandered through the treasures of art and science in the various halls and along the great galleries from which a bird's eye view could be obtained of the ever shifting scene below. Music added to the charm, provided the listener was not too near, when conversation became almost impossible. It is doubtful if there exists a finer place for a reception than a building of the nature of the Royal Scottish Museum, where even the solitary wanderer can find interest in the varied contents of the cases displayed to view.

The excursions arranged by the local committee were well patronised, the most popular perhaps being that to Rosyth and Hopetoun House, where the visitors were received and entertained by the Marquess of Linlithgow, and the visit to Dunfermline, on the invitation of the Carnegie Trustees. The long excursions to the Scott country and to the Trossachs also attracted many sightseers. Unfortunately those who visited the West encountered heavy rains; and one section of the party was driven the wrong way, thereby missing the stage at which lunch was provided, and returning home hungry and miserable after a twelve hours' fast. Particularly interesting also were the small excursions arranged for Old Edinburgh, for Swanston, the early home of R. L. Stevenson, and for other interesting places in the immediate vicinity. The garden party given by the local committee was, in a certain sense, an excursion to the finely appointed Zoological Park. This was on the Tuesday afternoon just as the weather became somewhat threatening. Fortunately the rain held off until the evening, and the members thoroughly enjoyed their visit to a park the natural beauties of which have been skilfully adapted to the needs of all types of wild animals.

The Senatus of the University of Edinburgh took advantage of the presence of the British Association to confer the honorary degree of Doctor of Laws on nine of the eminent strangers visiting the city. These were Sir Edward Thorpe, the President of the Association; Prof. Arrhenius, Director of the Physico-Chemical Department of the Nobel Institute, Stockholm; Prof. Kapteyn, of Groningen, the discoverer of the two star streams; Prof. Krogh, the eminent physiologist of Copenhagen and Nobel Laureate; Dr. Irving Langmuir, Schenectady, New York, well known for his electrical work and his investigations into the structure of atoms; Sir Oliver Lodge, probably the best known man of science in our midst; Sir William Ridgeway, Professor of Archæology

at Cambridge; Professor Vito Volterra, one of the foremost mathematicians of the day; and Prof. R. W. Wood, of Johns Hopkins University, Baltimore, famous for his brilliant experimental researches in optics. These outstanding representatives of science in its various branches were presented to the Vice-Chancellor, Sir Alfred Ewing, by Prof. Whittaker (acting for the Dean of the Faculty of Law), who hit off the characteristic work of each in the happiest phrasing.

Another side issue of the British Association meeting was the Royal Societies' dinner, at which the fellows of the Royal Societies of Edinburgh entertained as their guests the fellows of the Royal Society of London, the members of the Royal Irish Academy, and eminent foreign visitors to the meeting. The Maharaj Rana of Jhalawar was also a guest. This brilliant function was held in the Masonic Hall, probably the most artistic hall in Edinburgh. Nearly two hundred were present, and the guests and hosts were arranged in such a way that those representative of any one science formed a group at one of the tables. The toasts were proposed and responded to by speakers selected on a broad international basis, and the speeches were short, congratulatory, breezy, and humorous. One point referred to by Sir James Dewar is worth chronicling on account of its historic interest, and might have found a place in the handbook "Edinburgh's Place in Scientific Progress." Some seventy-five years ago a young extra-mural teacher, Dr. Samuel M. Brown, gave four lectures on the atomic theory and, to a large intellectual audience packed into his lecture room, broached ideas regarding the complicated nature of atomic structure which were far in advance of his day, and closely approximated to the ideas now so prevalent. Samuel Brown died at the age of thirty-nine, and Edinburgh lost a brilliant son who, had he lived, would have brought renown to his city.

For one glorious week the people of Edinburgh rejoiced in the British Association—just as profoundly as the visiting members of the Association rejoiced in Edinburgh. There was exhilaration in the very air, and the profoundest problems were tackled in a cheerful spirit. Two thousand seven hundred and sixty-eight members drawn together from all parts of the world shared in this intellectual feast of good things, the golden memories of which will be a life-long possession.

C. G. K.

Science and Crop Production.[1]

By E. J. Russell, D.Sc., F.R.S., Director of the Rothamsted Experimental Station.

THE beginning of much of our scientific work on crop production goes back to the year 1843, when Lawes and Gilbert set out to discover why farmyard manure is such an excellent fertiliser. Two opposing explanations were offered by the chemists of the day; the older view, coming down from the eighteenth century, was that the fertilising value lay in the organic matter; the newer view put forward by Liebig in 1840 was that it lay in the ash constituents—the potash, phosphates, etc.—left after the manure is burnt. Lawes and Gilbert considered that it lay in the ash constituents *plus* the nitrogen of the organic matter, and they devised a critical field experiment to decide the matter. They divided a field of wheat into plots of equal size, of which one received farmyard manure at the rate of 14 tons per acre, another received the ashes of exactly the same dressing of farmyard manure, a third received the mineral matter of the ashes *plus* some of the combined nitrogen that had been dissipated on burning, and a fourth lay unmanured. The results were very striking :—

Broadbalk Wheat Field, 1843.

	Grain. Tons per acre.	Straw. Cwts. per acre.
Farmyard manure	22	13
No manure	16	10
Ashes of farmyard manure ..	16	10
Mineral matter of ash *plus* sulphate of ammonia to supply combined nitrogen	26¼	15¾

[1] Abstract of a farmers' lecture of the British Association delivered at Edinburgh on September 7.

The ashes proved ineffective, but the ashes *plus* the combined nitrogen acted just as well as farmyard manure; it is therefore these that constitute the fertilising constituents of the manure. Thus the old controversy was decided in a way not uncommon in science; neither side proved to be entirely correct, but both sides were found to have some basis of truth. Lawes and Gilbert did not rest content with this purely judicial and scientific conclusion; they saw that they could make up this effective mixture of ashes and combined nitrogen from mineral substances without using farmyard manure. Even in their day farmers were unable to obtain sufficient farmyard manure, and it was therefore a great achievement to be able to supplement the limited supplies by this mixture. A factory was set up, and the manufacture of the so-called artificial fertilisers began. Subsequent experience showed that the ash constituents are not all equally necessary; in practice only two of them, potash and phosphates, need be supplied in addition to nitrogen.

Chemists are rightly proud of artificial fertilisers, for they have proved extraordinarily successful in augmenting crop production all over the world. The demand for them is enormous, and in consequence prices have risen considerably within the last thirty years. Agricultural chemists are always looking out for new substances, and even during the war a new fertiliser, ammonium chloride, was added to the list and new plant has been erected for its manufacture. Modern

manufacturing facilities are, perhaps, adequate for present demands, but it is certain that much more fertiliser could be used, and that as farming improves the demand will increase.

Progressive farmers have long passed the stage when it was necessary to demonstrate that artificial manures increase crop production; the position now is the much more difficult one of deciding how much money it is wise to spend on fertilisers. The old view was that the crop yield was proportional to the manurial dressing—*i.e.* that the more the manure the bigger the crop. Lawes and Gilbert showed this was not altogether correct, and that the yield fell off after a certain sized dressing was reached; this relationship is expressed by a straight line which ultimately becomes a curve. A later view set up by Mitscherlich was that the effect of the manure is proportional to the decrement from the maximum obtainable; that therefore the first dose of manure has a large effect; but that further doses have progressively less action. This relationship is expressed by a logarithmic curve. The present view is that the effect is at first small; then it increases and then decreases; this relationship is expressible by a curve resembling that for autocatalysis. The important practical consequence is that moderate dressings are more profitable than small ones, but they are also more profitable than much larger ones (Fig. 1). There is no difficulty about the general rule; the difficulty arises when one tries to define a moderate dressing. The problem is further complicated by the fact that the effect of the dressing is greatly influenced by the time when it is put on to the land. In our own case the results have been as follows:—

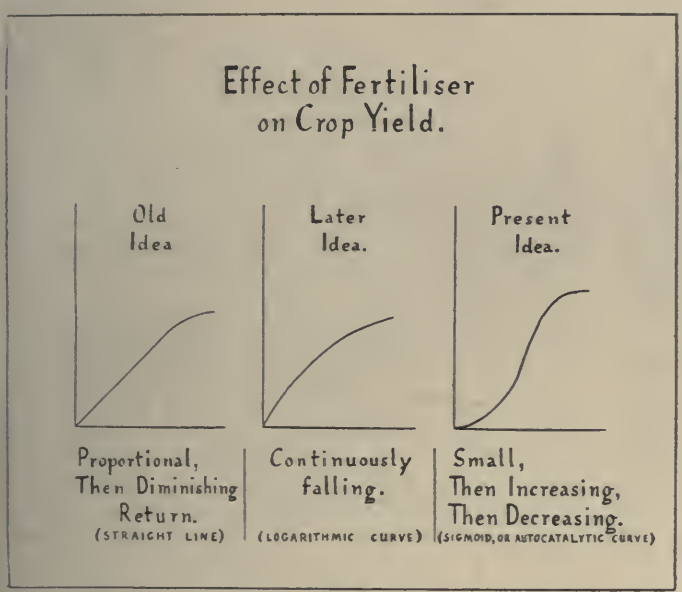

FIG. 1.—Curves showing relationship between crop yield (plotted on vertical axis) and quantity of fertiliser used (plotted on horizontal axis).

	Increased yield of grain. Bushels per acre.			Increased yield of straw. Cwts. per acre.		
Date of application of manure	Feb. 10	Mar. 6	May 10	Feb. 10	Mar. 6	May 10
Single Dressing ..	Nil.	0·9	2·7	2·7	6·9	9·4
Double Dressing ..	7·0	—	3·7	11·7	—	12·7

This experiment ought to be repeated in many districts, for it is by no means certain that farmers generally are using the most profitable quantities of fertiliser at the most effective time. It is, however, necessary to take into account something more than the quantity and the time of application of the fertiliser. It is essential also to have a suitable mixture. In the old days this question was thought to be fairly simple. Chemists used to think that if they knew the composition of the ash of plants they would know what manure to use; it should supply all the ash constituents in the quantities present in the plant. This is now known to be wrong; the composition of the ash affords no guidance to manurial requirements, as was, indeed, shown by Lawes and Gilbert in 1847. The distinguished French chemist, Georges Ville, emphasised the fact that only properly conducted field trials would ever settle the question. Vast numbers of such experiments have been made, and they show that the problem is more complex than Ville thought. It is now known that no single formula expresses the fertiliser needs of a crop; every district, almost every farm, has its own special requirements.

Still further difficulty is introduced by the fact that the various artificial fertilisers not only increase crop yields, but also influence the composition and habit of growth of the crop. Nitrogenous manures tend to a vegetative growth of large, deep-green leaves which are somewhat liable to be attacked by fungoid pests. Phosphates improve root development, and are therefore of special value for swedes and turnips; they also hasten ripening of grain, and are therefore particularly useful in late districts; they increase the feeding value of crops, and are therefore useful for fodder crops; and they have a remarkable effect on the development of clover, which is not yet fully understood, but which has revolutionised the treatment of pastures in this country. Potassic fertilisers improve the vigour of the plant and increase its power to resist fungus attacks. These and other special properties of fertilisers are now well established, and advantage is taken of them in drawing up fertiliser schemes to suit the special requirements of each farm.

It has already been pointed out that this work on artificial fertilisers arose out of Lawes and Gilbert's discovery that the wheat crop of 1843 grew just as well when supplied with the ash constituents *plus* combined nitrogen as when supplied with farmyard manure. They repeated the experiment year after year; periodically the results

were collected, and even after fifty years on an average the artificials had done as well as the farmyard manure. In consequence of this and other experiments many agricultural chemists developed the view that artificial manures were at least as good as farmyard manure for ordinary use on the farm; but wider knowledge has shown that this is not the case; it is only a first approximation to say that artificial fertilisers are equally as good as farmyard manure; we now know that farmyard manure produces effects of the highest importance to the land which no known combination of artificial fertilisers will bring about.

Examination of the Broadbalk data in the statistical laboratory recently instituted at Rothamsted under Mr. R. A. Fisher shows that farmyard manure differs in two ways from artificials—the variation in yield from year to year is diminished by the use of farmyard manure, as is also the deterioration in fertility due to continuous cropping for eighty years. No fewer than fifteen different combinations of fertilisers are tested against farmyard manure, and while some of them come out quite well on an average of twenty-five or fifty years, they fluctuate considerably from season to season, and they show manifest signs of deterioration as the years pass by. Many farmers prefer a steady yield to a fluctuating one, and this, of course, is sound, cautious business. Farmyard manure never does badly even in the worst seasons, but, on the other hand, it does not give record crops even in the best seasons. What we should like would be something possessing the special values of farmyard manure in bad seasons, and of artificials in good ones.

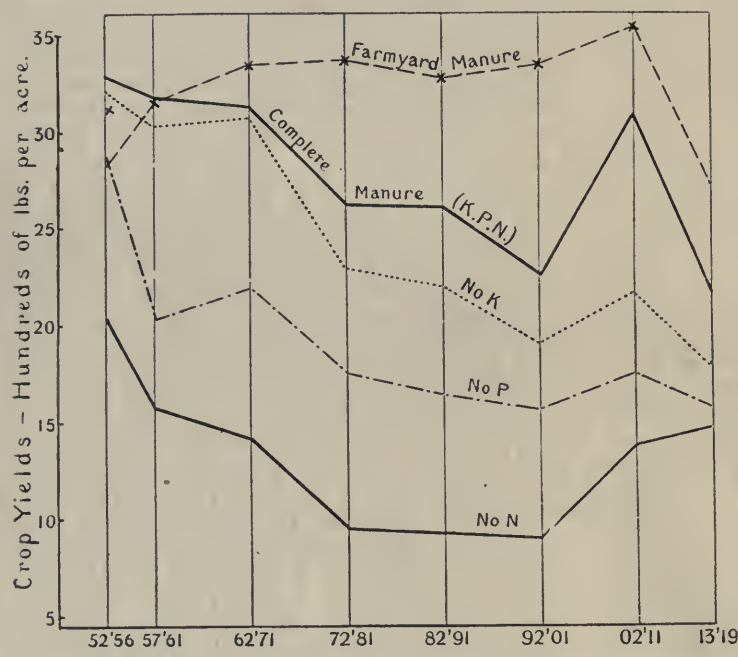

FIG. 2.—Effect of fertilisers on yield of barley. (Horsfield, Rothamsted, 1852–1919.)

Further, there is a deterioration of yield on all our plots treated with artificials excepting perhaps those receiving exceptionally high dressings. This is shown on both the wheat and the barley plots, and it is greatest on those plots where one of the essential fertiliser constituents is withheld (Fig. 2).

There is a third effect, which is very marked in rotations. Farmyard manure appears to have a greater effect than artificials in increasing the growth of clover. Unfortunately the number of experiments is not very great, but, so far as they go, they show a striking superiority over artificials, and this extends not only to the clover, but also to the succeeding wheat crop.

The results at Rothamsted are:—

Manure applied to previous corn crop.	Yield of clover hay. Cwts. per acre.	Yield of succeeding wheat crop. Grain. Bushels per acre.	Yield of succeeding wheat crop. Straw. Cwts. per acre.
Farmyard Manure ..	62	45	45·3
Artificials only	46	37	36·8

At present we cannot explain all these remarkable facts. There are several possibilities:—

(1) Farmyard manure is known to exercise remarkable physical effects on the soil, causing it to become puffed up so that the empty pore spaces increase in size. The air supply to the roots thus becomes better, the water supply is more evenly regulated, the work of the tillage implements is lightened, and a good tilth is more easily obtained. The difference is well shown by the root crops—swedes, turnips, and particularly mangolds, which are very sensitive to soil conditions, and, being sown late, are liable to suffer from spring and summer droughts. The plots at Rothamsted receiving farmyard manure contain always some 2–5 per cent. more moisture than those receiving no manure or artificials only, and this enables the mangolds to keep growing during a drought which effectually checks all plants not receiving farmyard manure.

(2) It is possible that there are chemical constituents in farmyard manure which are not present in our artificial fertilisers. The old idea that nitrates, potash, and phosphates only are necessary may be wrong. Recent work by Mazé in Paris and by Dr. Winifred Brenchley at Rothamsted show that some of the other elements may also be helpful. In the Rothamsted experiments very small quantities of boric acid added to the soil caused distinct increases in crops fully fertilised with artificial manures. We cannot as yet recommend farmers to adopt this kind of manuring with special substances, because it is very easy to overstep limits and do much damage to the crop, for the plant suffers seriously from even slight excess. With fuller knowledge, how-

ever, it may prove possible to keep this special manuring within bounds.

(3) In the case of the clover crop the farmyard manure or the straw in the litter may have a special effect on the organisms living in the root, causing them to increase the amount of nitrogen fixation and thus give larger clover crops and further enrich the soil in nitrogenous organic matter.

Work on these problems is progressing; the scientific investigator has, of course, to find out exactly what is happening before he can show the practical man how to exercise control.

But in the meantime it is necessary for us to be practical and to do something, and the most obvious line of action is to increase the amount of farmyard manure or similar substances on the farm. We can proceed in two ways; first, wastage can be cut down. We estimate that the farmers of the United Kingdom make about forty million tons of farmyard manure a year, and waste about ten million tons. We have shown that the best results are obtained when manure is made under cover and the amount of litter properly adjusted to the amount of nitrogen in the animal excretions. Correct adjustment is a counsel of perfection, but a great improvement is possible over the present haphazard methods. In practice nitrogen is always lost through exposure to weather, greatly to the detriment of the manure. The provision of some shelter for the heap is not difficult, and, as Prof. Berry has shown at Glasgow, it is distinctly advantageous.

Another method is to increase greatly the amount of farmyard manure or similar substances produced on the farm. This could be done by running on more animals. The number of livestock per acre could be much increased by the general adoption of the methods of some of the Scottish and Danish farmers, who keep their animals largely on the produce of their arable land. The problem is closely bound up with financial considerations, but the experiments of Mr. J. C. Brown at the Harper Adams Agricultural College show that more profit is obtainable from the soiling system than from the older methods of the south.

At Rothamsted we are examining possible substitutes for farmyard manure, green manuring, and the activated sludge method of producing manure from sewage, both of which seem quite promising. We tried using straw as manure, but without success; so soon, however, as the straw was rotted, much more promising results were obtained. The conditions for the proper rotting of straw, investigated at Rothamsted by Dr. H. B. Hutchinson and Mr. E. H. Richards, were found to be proper air and moisture supply, suitable temperature, freedom from acidity, and the proper proportion of soluble nitrogen compounds. All these conditions are easily obtainable on the farm, and it is now possible to make an artificial farmyard manure from straw without the intervention of animals. So far the results seem quite satisfactory. Arrangements are being made for demonstrations on an extensive scale during the present season.

All these problems I have been discussing represent work of interest to the present generation of farmers; but the scientific investigator cannot be restricted to problems of present-day interest. Some of the best work of to-day may never reach the farmer in our time, and, indeed, unless it is developed, it will never reach the farm at all. We now know that the farmyard manure and the green manure put into the soil are not really agents of fertility, but only raw materials out of which fertility is manufactured. The work is done by myriads of living creatures in the soil, which are too small to be seen by the naked eye, and only incompletely revealed even by powerful microscopes. Some of them are useful to the farmer and some not, many of them taking their toll of the valuable plant food in the soil. Their activity fluctuates daily, almost hourly, and their numbers are counted and their work is watched in our laboratories. Much of their activity is helpful to the farmer; it makes nitrates, indispensable for the growth of plants. Much of their time, however, is spent in undoing the good work they have done, and results in the destruction of a large proportion of the nitrates made. We are studying this population, and with fuller knowledge we hope to control it and make it serve the farmer just as horses, sheep, and cattle do; but we are a long way from that yet.

Finally an attack is being made on a much more difficult problem. The growth of a crop is like the movement of a motor-car; it cannot go on without a continuous supply of energy. In the case of the car the energy comes from the petrol; in the case of the growing crop it comes from sunlight. The plant as we grow it, however, is not a very efficient transformer; a crop of wheat utilises only about half of 1 per cent. of the energy that reaches it. During the last eighty years the growth of crops has been improved, thus increasing their efficiency as utilisers of energy; but we are still a very long way from the 30 per cent. efficiency which the motor engineer has attained. Better developments of our present methods will no doubt carry us further than we have yet gone, but some wholly fresh ideas are necessary before we can hope to bridge the enormous gap that now exists between the actual and what is theoretically possible. There seem to be at least six ways in which we might improve crop production :—

(1) We can hope for further improvements by the use of new varieties capable of making better growth than those ordinarily cultivated. Plant breeders all over the world are attacking this problem with much success, and many of the new sorts show considerable promise.

(2) Much can be done by control of plant diseases. Unfortunately we have no means of knowing how much is lost each year by pests or disease, but it is undoubtedly considerable. Laboratories for studying plant pathology have

been set up at Rothamsted and elsewhere, and we are hoping to achieve good results; much valuable information has already been obtained.

(3) We are also looking to the tractor to achieve great things on the farm. It will allow considerable development of cultivation implements, enable us to improve our tillage and to keep down weeds, a very serious trouble in the southern part of England. Good Scottish farmers in that region have told me that farming in Scotland is much easier than in England, because the rigorous northern winters keep weeds in check, while the mild southern winters encourage their growth.

(4) It is possible that certain substances, such as boric acid, the fluorides, etc., studied by Gautier and Claussmann in France, may help in raising crop growth.

(5) It is possible also that special methods may prove of value, such as the high-tension discharge tested by Miss Dudgeon at Lincluden, Dumfries, and ably and critically studied by Prof. V. H. Blackman.

(6) Finally, it seems probable that some wholly new method may be found for increasing crop growth. In most civilised countries there are now research institutes where the ways of plants and the properties of soils are being studied. Men of science, as a rule, do not care to risk prophecies or to attempt to create sensations, and I certainly am not going to break this wholesome rule. Something, however, has already been done; in spite of the decreased labour spent on cultivation, the yields tend to go up, while the new knowledge that is now being gained is adding greatly to the pleasure of farming and giving both masters and men an interest in their work that they never had before.

Applied Geography.[1]

By D. G. HOGARTH, M.A., D.Litt., C.M.G.

THE term "applied geography" has been in use for some years as a general designation of lendings or borrowings of geographical results, whether by a geographer who applies the material of his own science to another, or by a geologist or a meteorologist, or again an ethnologist or historian, who borrows of the geographer. Whether geography makes the loan of her own motion or not, the interest in view, as it seems to me, is primarily that, not of geography, but of another science or study.

Such applications are of the highest interest and value as studies, and, still more, as means of education. As studies, not merely are they links between sciences, but they tend to become new subjects of research, and to develop with time into independent sciences. As means of education they are used more generally, and prove themselves of higher potency than the pure sciences from which or to which, respectively, the loans are effected. But, in my view, geography, thus applied, passes, in the process of application, into a foreign province and under another control. It is most proper, as well as most profitable, for a geographer to work in that foreign field; but, while he stays in it, he is, in military parlance, seconded.

Logical as this view appears to me, and often as, in fact, it has been stated or implied by others (for example, by one at least of my predecessors in this chair, Sir Charles Close, who delivered his presidential address to the section at the Portsmouth meeting in 1911), it does not square with some conceptions of geography put forward by high authorities of recent years. These represent differently the status of some of the studies, into which, as I maintain, geography enters as a secondary element. In particular, there is a school, represented in this country and more strongly in America, which claims for geography what, in my view, is an historical or ethnological or even psychological study, using geographical data towards the solution of problems in its own field; and some even consider this not merely a function of true geography, but its principal function now and for the future. Their "new geography" is and is to be the study of "human response to land-forms." This is an extreme American statement; but the same idea is instinct in such utterances, more sober and guarded, as that of a great geographer, Dr. H. R. Mill, to the effect that the *ultimate* problem of geography is "the demonstrative and quantitative proof of the control exercised by the earth's crust on the mental processes of its inhabitants." Dr. Mill is too profound a man of science not to guard himself, by that saving word "ultimate," from such retorts as Prof. Ellsworth Huntington, of Yale, has offered to the extreme American statement. If, the latter argued, geography is actually the study of the human response to land-forms, then, as a science, it is in its infancy, or, rather, it has returned to a second childhood; for it has scarcely begun to collect exact data to this particular end, or to treat them statistically, or to apply to them the methods of isolation that exact science demands. In this country geographers are less inclined to interpret "new geography" on such revolutionary lines; but one suspects a tendency towards the American view in both their principles and their practice—in their choice of lines of inquiry or research and their choice of subjects for education. The concentration on man, which characterises geographical teaching in the University of London, and the almost exclusive attention paid to economic geography in the geographical curricula of some other British universities tend in that direction.

[1] Abridged from the presidential address delivered to Section E (Geography) of the British Association at Edinburgh on September 8.

In educational practice this bias does good, rather than harm, if the geographer bears in mind that geography proper has only one function to perform in regard to man—namely, to investigate, account for, and state his distribution over terrestrial space—and that this function cannot be performed to any good purpose except upon a basis of physical geography—that is, on knowledge of the disposition and relation of the earth's physical features so far as ascertained to date. To deal with the effect of man's distribution on his mental processes or political and economic action is to deal with him geographically, indeed, but by applications of geography to psychology, to history, to sociology, to ethnology, and to economics, for the ends of these sciences; though the interests of geography may be, and often are, well served in the process by reflection of light on its own problems of distribution. If in instruction, as distinct from research, the geographer, realising that, when he introduces these subjects to his pupils, he will be teaching them not geography, but another science with the help of geography, insists on their having been grounded previously or elsewhere in what he is to apply—namely, the facts of physical distribution—all will be well. The application will be a sound step forward in education, more potent perhaps for training general intelligence than the teaching of pure geography at the earlier stage, because making a wider and more compelling appeal to imaginative interest and pointing the adolescent mind to a more complicated field of thought. But if geography is applied to instruction in other sciences without the recipients having learned what it is in itself, then all will be wrong. The teacher will talk a language not understood, and the value of what he is applying cannot be appreciated by the pupils.

It will be patent enough by now that I am maintaining geography proper to be the study of the spatial distribution of all features on the surface of the earth. My view is, of course, neither novel nor rare. Almost all who of late years have discussed the scope of geography have agreed that distribution is of its essence. Among the most recent exponents of that view have been two directors of the Oxford school, Sir Halford Mackinder and Prof. Herbertson. When, however, I add that the study of distribution, rightly understood, is the whole essential function of geography, I part company with the theory of some of my predecessors and contemporaries, and the practice of more. But our divergence will be found to be not serious; for not only do I mean a great deal by the study of distribution—quite enough for the function of any one science!—but also I claim for geography to the exclusion of any other science all study of spatial distribution on the earth's surface. This study has been its well recognised function ever since a science of that name has come to be restricted to the features of the terrestrial surface—that is, ever since "geography" in the eighteenth century had to abandon to its child geology the study of what lies below that surface even as earlier it had abandoned the study of the firmament to an elder child, astronomy. Though geography has borne other children since, who have grown to independent scientific life, none of these has robbed her of that one immemorial function. On the contrary, they call upon her to exercise it still on their behalf.

Let no one suppose that I mean by this study and this function merely what Prof. Herbertson so indignantly repudiated for an adequate content of his science—physiography *plus* descriptive topography. Geography includes these things, of course, but she embraces also all investigation both of the actual distribution of the earth's superficial features and of the causes of the distribution, the last a profound and intricate subject towards the solution of which she has to summon assistance from many other sciences and studies. She includes, further, in her field, for the accurate statement of actual distribution, all the processes of survey—a highly specialised function to the due performance of which other sciences again lend indispensable aid; and, also, for the diagrammatic presentation of synthetised results for practical use, the equally highly specialised processes of cartography. That seems to me an ample field, with more than sufficient variety of expert functions, for any one science.

I have claimed for the geographer's proper field the study of the causation of distribution. I am aware that this claim has been, and is, denied to geography by some students of the sciences which he necessarily calls to his help. But if a science is to be denied access to the fields of other sciences unless it take service under them, what science shall be saved? I admit, however, that some disputes can scarcely be avoided, where respective boundaries are not yet well delimited. Better delimitation is called for in the interest of geography, because lack of definition, causing doubts and questions about her scope, confuses the distinction between the science and its application. The doubts are not really symptoms of anything wrong with geography, but, since they may suggest to the popular mind that in fact something is wrong, they can be causes of disease. Their constant genesis is to be found in the history of a science the scope of which has not always been the same, but has contracted during the course of ages in certain directions while expanding in others. If, in the third century B.C., Eratosthenes had been asked what he meant by geography, he would have replied, the science of all the physical environment of man whether above, upon, or below the surface of the earth, as well as of man himself as a physical entity. He would have claimed for its field what lies between the farthest star and the heart of our globe, and the nature and relation of everything composing the universe. Geography, in fact, was then not only the whole of natural science, as we understand the term, but also everything to which another term, ethnology, might now be stretched at its very widest.

Look forward now across two thousand years to the end of the eighteenth century A.D. Geo-

graphy has long become a mother. She has conceived and borne astronomy, chemistry, botany, zoology, and many more children, of whom about the youngest is geology. They have all existences separate from hers and stand on their own feet, but they preserve a filial connection with her and depend still on their mother science for a certain common service, while taking off her hands other services she once performed. Restricting the scope of her activities, they have set her free to develop new ones. In doing this she will conceive again and again and bear yet other children during the century to follow—meteorology, climatology, oceanography, ethnology, anthropology, and more. Again, and still more narrowly, this new brood will limit the mother's scope; but ever and ever fecund, she will find fresh activities in the vast field of earth knowledge, and once and again conceive anew. The latest child that she has borne and seen stand erect is geodesy; and she has not done with conceiving.

Ever losing sections of her original field and functions, ever adding new sections to them, geography can scarcely help suggesting doubts to others and even to herself. There must always be a certain indefiniteness about a field on the edges of which fresh specialisms are for ever developing towards a point at which they will break away to grow alone into new sciences. The mother holds on awhile to the child, sharing its activities, loth to let go, perhaps even a little jealous of its growing independence. It has not been easy to say at any given moment where geography's functions have ended and those of, say, geology or ethnology have begun. Moreover, it is inevitably asked about this fissiparous science from which function after function has detached itself to lead a life apart—what, if the process continues, as it shows every sign of doing, will be left to geography? Will it not be split up among divers specialisms, and become in time a venerable memory? It is a natural, perhaps a necessary, question. But what is wholly unnecessary is that any answer should be returned which implies a doubt that geography has a field of research and study essentially hers yesterday, to-day, and to-morrow; still less one which implies any suspicion that, because of her constant parturition of specialisms geography is, or is likely to be in any future that can be foreseen, moribund.

Since geography, as I understand it, is a necessary factor in the study of all sciences, and must be applied to all if their students are to apprehend rightly the distribution of their own material, it is a necessary element in all education. Unless, on one hand, its proper study be supported by such means as the State, the universities, and the great scientific societies control, and, on the other, its application to the instruction of youth be encouraged by the same bodies, the general scientific standard in these islands will suffer; our system of education will lack an instrument of the highest utility for both the inculcation of indispensable knowledge and the training of adolescent intelligence; and a vicious circle will be set up, trained teachers being lacking in quantity and quality adequate to train pupils to a high enough standard to produce out of their number sufficient trained teachers to carry on the torch.

The present policy of the English Board of Education, as expressed in its practice, encourages a four-years' break in the geographical training of the young, the break occurring between the ages of fourteen and eighteen, the best years of adolescent receptivity. If students are to be strangers to specifically geographical instruction during all that period any geographical bent given to their minds before the age of fourteen is more than likely to have disappeared by the time they come to eighteen years. The habit of thinking geographically—that is, of considering group distribution—cannot have been formed; and the students, not having learned the real nature of the science applied, will not possess the groundwork necessary for the apprehension of the higher applications of geography. Moreover, as Sir Halford Mackinder has rightly argued, an inevitable consequence of this policy is that the chief prizes and awards offered at the end of school-time are not to be gained by proficiency in geography. Therefore, few students are likely to enter the university with direct encouragement to resume a subject dropped long before at the end of the primary period of their education.

It is not, of course, the business of schools, primary and secondary, to train specialists. Therefore one does not ask that pure geographical science should have more than a small share of the compulsory curriculum—only that it have some share. If this is assured, then its applications, which on account of their highly educative influence deserve an equally compulsory but larger place in the curriculum, can be used to full advantage. The meaning and value of the geographical ingredient in mixed studies will stand a good chance of being understood, and of exciting the lively interest of young students. In any case, only so will the universities be likely to receive year by year students sufficiently grounded to make good use of higher geographical courses, and well enough disposed to geography to pursue it as a higher study and become in their turn competent teachers.

The obligation upon the universities is the same in kind, but qualitatively greater. They have to provide not only the highest teaching, both in the pure science and its applications, but also such encouragements as will induce students of capacity to devote their period of residence to this subject. The first part of this obligatory provision has been recognised and met in varying degrees by nearly all British universities during the past quarter of a century. A valuable report compiled recently by that veteran champion, Sir John Keltie, shows that, in regard to geography, endowment of professorial chairs, allocations of stipends to readers, lecturers, and tutors, supply of apparatus for research and instruction and organisation of "honours" examinations, have made remarkable progress in our university world

as a whole. But no British university has yet provided all that is requisite or desired. Oxford and Cambridge, which have well-equipped geographical laboratories, still lack professorial chairs. Liverpool, maintaining a well-staffed department of geography, and London, which, between University College and the School of Economics, provides all the staff and apparatus required for teaching, have endowed chairs; but they direct the attention of the holders to applications of geography rather than to the pure science. So also do the University of Manchester and the University College of Wales, both of which maintain professors of geography.

All the universities, with but one or two exceptions, examine in the subject to a high standard, that set by Cambridge being perhaps the highest over the whole field of properly geographical study. This latter university, also, has met the second part of her obligation to geography by the organisation of an honours course of instruction and classified examination, which, if pursued throughout a student's residence, is sufficient in itself to secure graduation. At Cambridge, therefore, geography may be said to stand on a par with any other self-contained final subject. Neither in London nor in Manchester (I am not quite sure about Liverpool, but believe its case to be the same) is geography, in and by itself, all-sufficient yet to secure graduation, though at London the supplementary subject is so far subordinated to geography that the degree is taken as in the latter subject. Oxford offers distinctly less encouragement at present than any of the universities just mentioned. Her teaching and her examination standard are as advanced as the best of theirs, and the highest award which she gives for proficiency in geography, her diploma "with distinction," counts towards the B.A. degree as two-thirds of the whole qualification; but—and here's the rub!—the balance has to be made up by proficiency in some other subject up to a pass, not an honours, standard. Therefore the resultant degree does not stand before the world as one taken in honours; and, although some candidates are notified as distinguished and some not in the geographical part of her examinations, the distinction is not advertised in the form to which the public is accustomed—namely, an honours list divided into classes. The net result is that an Oxford diploma, however brilliantly won, commands less recognition in the labour market than would a class in an honours school or tripos. It should, however, be mentioned—though an infrequent occurrence, not advertised by a class list, makes little impression on public opinion—that special geographical research, embodied in a thesis, can qualify at Oxford for higher degrees than the B.A.—viz. for the B.Litt. and B.Sc.—without the support of other subjects.

The reason of this equivocal status of geography at Oxford is simply that, so far as the actual faculties which control the courses for ordinary graduation are concerned, geography is, in fact, an equivocal subject. No one faculty feels that it can deal with the whole of it. The arts faculties will not accept responsibility for the elements of natural and mathematical science which enter into its study and teaching—for example, into the investigation of the causes of distribution, into the processes of surveying, into cartography, and into many other of its functions. Moreover, the traditional Oxford requirement of a literary basis for arts studies is hard, if not impossible, to satisfy in geography. The faculty of natural science, on the other hand, is equally loth to be responsible for a subject which admits so much of the arts element, especially into those applications of its data which enter most often into the instructional curriculum of adolescents—for example, its applications to history and to ethnology.

At this moment, then, there is an *impasse* at Oxford similar to that (it is caused by the same reason) which prevents the election of a geographer, as such, either to the Royal Society on the one hand, or to the British Academy on the other. But ways out can be found if there be good will towards geography, and such general recognition of the necessity of bringing it into closer relation with the established studies as was implied by the examiners in the Oxford school of Literae Humaniores last year, when, in an official notice, they expressed their sense of a lack of it in the historical work with which they had to deal. Faculties are comparatively modern organisations at Oxford as at Cambridge for the control of teaching and examining. Before them existed boards of studies, appropriated to narrower subjects; and, indeed, such boards have been constituted since faculties became the rule and side by side with them. The board, which at first controlled at Oxford the final honours school of English, is an example and a valid precedent. Cambridge has found it possible to organise a mixed board of studies to manage a final school of geography, the board being composed of representatives of both the arts subjects and the natural and mathematical sciences; and this acts apparently to the general satisfaction even in the absence of a professor of the special subject for the teaching and testing of which it was formed. Why, then, should Oxford not do likewise? If Cambridge has not waited for the endowment of a professorial chair in geography, need Oxford wait? I am well aware that, when at the latter university the school of English came into existence, there were already two chairs appropriated to its subject; and I grant that Oxford will not have the very best of all guarantees that a high standard will be maintained in the instructional courses and the examinations in geography until there is a professor *ad hoc*. But guarantees sufficient for all practical purposes she could obtain to-morrow by composing a board out of her existing teachers of geography and kindred sciences.

For the last time, then, let me rehearse the too familiar "vicious circle." The supply of good students depends on a supply of good teachers; the supply of good teachers depends on a supply

of good students. If either supply fails, it is not geography alone, but all sciences and studies, that will be damnified; for all require the best of the help she can give in proportion as her science grows and improves. History will be able to call but indifferent geography to her assistance if this science has been understaffed and discouraged by official reluctance to allow it a place of its own in the sun. Is there not still some such reluctance on the part of the Board of Education, of some of our universities, and of the Civil Service Commissioners?

Stellar Parallax.

By J. JACKSON, Chief Assistant, Royal Observatory, Greenwich.

THE determination of stellar distances is fundamental to the investigation of the sidereal universe. When once the distance of a star is known, we can calculate its transverse speed in kilometres a second from its proper motion in seconds of arc per century, and we can determine its absolute brightness from its apparent brightness. For binary stars at known distances we can determine the separation of the components in kilometres, and this, together with the period, enables us to compute the mass of the system. Recent work at Mount Wilson has shown that it is practicable to determine the angular diameter of the larger stars, and for such stars a knowledge of the parallax will enable us to compute the linear diameter. Many of the investigations about the sidereal universe made during the last twenty years have been possible only through the increase in the number of stars the distances of which are known with reasonable accuracy, and the results obtained have been of such importance that in an increasing degree the energy of astronomers is being directed to supply the required data.

The direct determination of stellar distances depends on triangulation from the earth at different positions in its annual path round the sun. The apparent motion of a star can be analysed into a linear component due to the relative motion of the sun and the star, and a periodic motion due to the motion of the earth round the sun. The parallax of a star is the angle subtended by the earth's radius at the distance of the star, and is equal to the semi-major axis of the apparent ellipse described by the star as a result of the earth's orbital motion. It is therefore determined from observations made as nearly as practicable at the times when the star is at the ends of the major axis of the "parallactic ellipse."

The principle to be used in the determination of stellar distances was obvious as soon as the Copernican theory of the solar system was recognised. The difficulty in applying the principle is due to the extreme minuteness of the change in angle which is to be measured after a six months' interval. Had it been known or assumed that the stars were comparable in real brightness with our sun, although they appeared about a million million times fainter, it could have been calculated that their parallaxes were less than a second of arc. Successive attempts to measure the parallaxes of selected stars for long necessarily met with failure, although they led to many important discoveries. In the first half of the eighteenth century Bradley made a remarkable series of observations of the meridian zenith distance of the star γ Draconis—a star which passed the meridian near the zenith so that the angles to be measured were relatively small, while errors introduced by varying atmospheric conditions were reduced to a minimum. He discovered aberration and later nutation through these observations, and proved that the parallax of this star was less than a second. Observations of the same kind might later have led to the discovery of latitude variation. The attempt made by Sir William Herschel towards the end of the eighteenth century may also be noted here. Instead of attempting to determine the absolute parallax of separate stars which involves the measurement of large angles from the vertical or some other direction which it is supposed can be accurately identified after a six months' interval, he attempted only to discover relative parallaxes from the relative displacements of stars in nearly the same direction, but probably at very different distances. The method is essentially that now used almost exclusively; but where Herschel applied it to pairs of stars actually at different distances, his observations were not sufficiently accurate to reveal the parallactic motion. His most extensive series of observations were made of fairly bright pairs of stars within a few seconds of arc, and the motion he actually discovered was orbital motion of the stars, which proved that they were really close together in space and revolving round one another under gravitational attraction. This discovery led to the systematic study of double stars.

Success in the determination of stellar parallax was obtained almost simultaneously about 1838 by three observers employing different methods on different stars. The principal credit is usually given to Bessel for his determination of the parallax of 61 Cygni—a pair of faint stars with large proper motion—relative to faint neighbouring stars by means of the heliometer. This instrument consists of an ordinary telescope with the object glass cut in two along a diameter, and means are supplied for rotating the object glass and for sliding the two halves along their common diameter. With this instrument each star forms two images, and the observation consists in bringing an image of one star into coincidence with the other image of the other star. The

heliometer can be used to measure angular distances of several minutes with an accuracy second only to that of the modern photographic telescope. The other determinations of parallax were by Struve, who observed α Lyræ relative to faint stars in its neighbourhood by means of a position micrometer as used for double stars, and by Henderson, who used meridian observations in both co-ordinates of α Centauri.

During the next fifty years a number of observers made parallax determinations by these three methods, but although they showed great skill in their work and prosecuted it with the greatest assiduity, it cannot be said that many trustworthy results were obtained. The errors to which even the best results are liable are shown by the following seven determinations of the parallax of Procyon made by Elkin with the Yale heliometer :—

″ 0·257 ± 0·018	″ 0·503 ± 0·049
0·461 ± 0·035	0·294 ± 0·019
0·367 ± 0·018	0·228 ± 0·020
0·366 ± 0·023	

Soon after the first application of photography to astronomy it was found that star places could be determined with great accuracy from photographic plates. It was only natural that attempts should be made to apply the new method to parallax determination. The initial results showed no greater accuracy than those obtained visually, but gradually the difficulties have been overcome, and a remarkable degree of accuracy attained. It might have been supposed that the development of a photographic plate would lead to a distortion sufficiently great to vitiate the results, but apparently this is not the case. In fact, the distortion is less than 0·001 millimetre and can be ignored. The difficulty is to eliminate systematic errors in the apparent centres of the star images on the plates so as to get the photographs to faithfully represent the heavens at the different epochs. Provision must be made for the automatic elimination of every imaginable source of systematic error, since every preconceived source of possible error has turned out to be a reality. The most important precautions to be taken were pointed out about twenty years ago by Kapteyn in the first of the Groningen Publications. These include the taking of all the photographs under as nearly as possible the same instrumental conditions—the telescope should always be on the same side of the pier, and as nearly as possible in the meridian. These precautions are now obvious, as not only is the objective liable to behave differently in different positions, but the atmospheric effect might vary differently for the different stars, as they are not all of the same colour. A more serious source of error, called the "guiding error," was pointed out by Kapteyn. For the brighter stars an impression is produced on the photographic plate more quickly than for the fainter stars, so that if during the exposure an error in guiding allows all the stars to be slightly displaced for a short time, the brighter stars will show an elongated image with a displaced centre, while the fainter stars will show round undisplaced images. For this reason Kapteyn urged the importance of good guiding. But it is impossible to guide sufficiently well, and the difficulty was satisfactorily surmounted only when Schlesinger introduced the occulting shutter. This is a sector which is made to rotate rapidly in front of the star the parallax of which is to be determined. By reducing the opening in the sector, the time during which the "parallax star" is exposed is reduced relatively to the other stars. It is usual for the comparison stars to be of the 10th or 11th magnitude, while the "parallax stars" are generally considerably brighter. It is possible by means of the rotating sector to cut down the brightness by five magnitudes. For the very bright stars this is not enough, and some observers have used two rotating sectors to give the required reduction. Another method is to place a screen in front of the brighter stars. It is now generally recognised that it is most important to have the parallax star and the comparison stars forming images of nearly equal size and density. At the same time, every care is made to have the guiding as accurate as possible. In this connection the exposure should be as short as will produce readily measurable images—two or three minutes with photographic refractors with an aperture of 20 or 30 in.

Kapteyn's plan was to photograph the region under consideration at three different epochs on the same plate, which was stored between the exposures and developed only after the third epoch. The times of exposure were chosen so as to give maximum parallactic displacement in one direction at the first and third epochs, and maximum parallactic displacement in the opposite direction at the middle epoch. For example, a region might be given three exposures in May of one year, six in the following September, and three in the next May. The telescope would be moved slightly between the exposures, and for each star there would be twelve images on the plate. As all the images of each star would lie close together, it would only be necessary to measure very small distances on the plate, while by a symmetrical arrangement of the images any possible distortion of the film would be eliminated. This method is ideal, and was applied to some extent, but on account of bad weather interfering with the exposures it has practically been abandoned. The photographs at the different epochs are now taken on separate plates, and this method allows of greatest weight being given to those exposures made under the best atmospheric conditions.

The difficulties to be overcome having been fully realised, and the necessary precautions having been devised, a large scheme for the determination of parallaxes has been undertaken. In this work the Allegheny, Dearborn, Greenwich, McCormick, Mount Wilson, Sproul, and Yerkes Observatories take part. The following table

shows the aperture and focal length of the telescopes used :—

	Aperture. Inches	Focal length. Feet
Allegheny	30	46
Dearborn	18½	23
Greenwich	26	22½
McCormick	26	32½
Mount Wilson ...	60	80
Sproul	24	36
Yerkes	40	62½

The telescope used at Mount Wilson is a reflector, while the others are refractors. It will be seen that the focal length varies considerably from one instrument to another, but the probable error of a parallax determined from about fifteen plates is in all cases about 0·01″ or a little less. The explanation given is that with average conditions of working the images are larger for the longer telescopes. The aperture is also a point of some importance, as with larger aperture the duration of the exposure can be cut down, and with it the "guiding error." However, as some of the larger telescopes are really visual telescopes, and require a colour screen or special plates, the advantage they would otherwise have is reduced.

Considerable progress has already been made in carrying out this scheme of co-operation, and probably at least 200 parallaxes a year are being determined. The value of this contribution to our knowledge of stellar distances is realised when we recall that in 1880 we knew the parallaxes of only about twenty stars, while as late as 1915 the number had risen only to about 200. As one of the recent large publications we may instance the 260 determinations made at the McCormick Observatory in the five years 1914 to 1919.[1]

Let us consider the first star in this list. It is β Cassiopeiæ, a star of magnitude 2·4 with a proper motion of 55″ a century. The parallax was found from the rather large number of twenty-eight plates exposed as follows :—

1914	July	1	1916	Aug.–Sept. ...	4
	Nov.–Dec. ...	5		Nov.–Dec. ...	5
1915	Aug.	3	1917	Aug.	3
	Nov.–Dec. ...	3		Nov.–Dec. ...	4

The parallax found was 0·058″ ± 0·011″, in satisfactory agreement with other determinations, of which we may quote 0·051″ ± 0·015″ determined by Smith with the heliometer, and 0·074″ ± 0·011″ found by photography at the Allegheny Observatory. The proper motion in right ascension was found to be +0·524″, as compared with +0·529″ found by Boss from meridian observations extending through about 150 years. But the agreement is not always so satisfactory. Consider, for example, the star γ Ceti, which forms the double Σ 299. The components are of magnitudes 3·6 and 6·8, and are separated by about 3″. The duplicity of the star might well lie at the root of the trouble, although with suitable exposures the fainter star should not be seen. The parallax found with the Yale heliometer was 0·119″ ± 0·017″, that by photography at Allegheny 0·014″ ± 0·008″, and that at the McCormick Observatory 0·037″ ± 0·008″. The photographic parallaxes may be considered as in fair agreement, but the proper motion in right ascension was found to be −0·059″ (from plates extending 1½ years), as against −0·147″ found by Boss from observations extending 150 years. The photographic proper motion was checked by plates giving an interval of 3½ years, during which time the difference in proper motion amounted to no less than 0·3″. This cannot be explained by the orbital motion of the components, which is extremely slow, and it is difficult to attribute it to all four comparison stars, which on examination showed no appreciable proper motion. Results of this kind are by no means uncommon, and the greatest caution has to be used in applying small parallaxes from single determinations.

It may be considered that parallaxes greater than 0·05″ may be used in calculations concerning individual stars. For smaller parallaxes the accidental errors will make the results untrustworthy. It has been estimated[2] that there are about 2000 stars with a parallax as great as 0·05″, although most of them will be as faint as the 10th magnitude and not attract notice. As the number of stars to this magnitude is of the order of a million, it will be difficult to identify the stars which are near, but faint. Stars chosen at random will therefore generally give very small parallaxes. Most observing programmes, therefore, contain specially selected stars, such as very bright stars, stars with large proper motion, and binary stars in rapid orbital motion for which a fairly large parallax may be expected.

On account of this selection of the stars great care has to be exercised in discussions based on the measured parallaxes. Many facts, however, have been brought to light. The most important of these correlate what may be called the apparent qualities of a star with its absolute qualities. By the former we mean those qualities which can be found from observation without a knowledge of the distance, such as the nature of the light a star emits, or its angular motion, and by the latter the intrinsic qualities, such as real brightness, mass, and linear speed. Probably the most important results are those which have been reached at Mount Wilson, where for the later-type stars the relative intensity of certain spectral lines has been correlated with the absolute brightness. It is then a simple matter to deduce the distance from our knowledge of the absolute and apparent brightness. Parallaxes determined in this way are called "spectroscopic parallaxes," and recently a list of 1646 of these has been published by the Mount Wilson observers. Again, for double stars with known orbits and known parallax the mass of the system can be computed. It is found that the mass of all systems does not differ widely from twice that of the sun. Assuming this mass, we can compute "hypothetical" or "dynamical"

[1] Publications of the Leander McCormick Observatory of the University of Virginia, vol. 3.

[2] Eddington, "Stellar Movements," p. 15.

parallaxes from double stars for which the relative motion is known. Again, although the linear speed differs considerably from one star to another, the proper motions of stars can be considered as an index to the distance—a much better index than the apparent brightness.

In these and other indirect ways our knowledge of stellar distances is being rapidly advanced. It must be remembered that it is all ultimately based on measured or trigonometric parallaxes. The larger trigonometric parallaxes can be applied directly to the individual stars concerned, but for the smaller parallaxes the discussions must be of a statistical nature, as the errors of observation are too great. The indirect methods can, however, be pushed to stars at very great distances if only they appear bright enough for the necessary observations to be made.

Obituary.

JOHN ROBERT PANNELL.

JOHN ROBERT PANNELL, who was killed in the disaster to the airship R38 while making observations on behalf of the National Physical Laboratory, was the only surviving child of Mr. and Mrs. Pannell, of Nutley. He was born in 1885. A delicate childhood, which none would have suspected from his adult physique, interfered greatly with his education, but after courses at the Northampton Institute and some engineering works experience he joined the National Physical Laboratory in 1906 as a student assistant.

His best-known work is that carried out in conjunction with Mr. Stanton on dynamical similarity in the flow of liquids in pipes, which has become classical as the most complete demonstration of that principle in its important applications to hydrodynamics. With Mr. Stanton he also investigated with great elaboration the strength of welded joints; but most of his work is to be found in reports to the Advisory Committee for Aeronautics covering almost the whole range of experimental inquiry in aerodynamics. When problems of airship construction became prominent in 1916 he took part in most of the model measurements on resistance and the efficiency of controls; and when, again, after the war, it became possible to compare the results of model and full-scale tests, Pannell took charge of the latter and was constantly making observations on airships in flight.

In a science so little amenable to general theory the ability to make long and tedious series of routine measurements without allowing familiarity to breed carelessness is of special importance. This ability Pannell possessed in the highest degree. He had that genial serenity and evenness of temper often associated with one of his gigantic stature; neither the perversity of apparatus nor the impatience of petulant colleagues could make him relax for a moment the precautions that are the first necessity of such work. If the human tragedy of the R38 is partially compensated by a gain to science, that gain will be largely due to merits in Pannell's work which are too often eclipsed by more brilliant but not more useful achievements.

In private life the most lovable of men, he radiated kindness and good temper. He was of tireless physical energy, and his war-time leisure, devoted to a small farm, shamed the full-time occupation of many men. He leaves a widow, the true partner of all his labours, with whom all will feel sympathy in the exact measure of their acquaintance. N. R. C.

WE learn, with regret, of the death on September 10, from drowning near Ottawa, of Mr. F. W. L. SLADEN, author of "The Humble-bee: Its Life-history and How to Domesticate It." Mr. Sladen was forty-five years of age.

THE death of Mr. JOHN PEARCE ROE took place on September 2. Mr. Roe was born in 1852, and was the chairman and managing director of Ropeways, Ltd., of London. He carried out a large amount of work in connection with the transporting of materials by means of aerial ropeways.

Notes.

THE *Chemical Age* announces that Sir William Pope has been elected an honorary fellow of the Canadian Institute of Chemistry.

IT is announced that the annual meeting for 1922 of the British Medical Association will be held at Glasgow on July 21–29. The authorities of Glasgow University have given the association permission to use the University buildings, and offers of assistance should be addressed to Dr. G. A. Allen and Dr. J. Russel at the University.

WE learn from the *Lancet* of September 17 that the Health Committee of the League of Nations is constituted as follows:—Dr. Léon Bernard, professor of hygiene in the University of Paris; Dr. G. S. Buchanan, senior medical officer of the British Ministry of Health; Prof. A. Calmette, director of the Pasteur Institute in Paris; Dr. Carozzi, medical director of the International Labour Bureau; Dr. Henri Carrière, director-general of the Swiss Public Health Service; Sir Havelock Charles, president of the Medical Board for India; Dr. Chodzko, Minister of Health for Poland; Dr. Lutrario, director-general of the Italian Public Health Service; Dr. Th. Madsen, director of the State Institute of Serotherapy at Copenhagen; Prof. Miyajima, of the Kitasato Institute for Infectious Diseases, Tokyo; Dr. Pulido, president of the Spanish Royal Council of Public Health;

Mr. O. Velghe, director-general of the Belgian Public Health Service; and Prof. C.-E. A. Winslow, director of the League of Red Cross Societies. Dr. Rajchman, of Warsaw, has been appointed permanent medical director.

THE following lectures have been arranged for delivery at the Royal College of Physicians:—The Mitchell lecture, on "The Relations of Tuberculosis to General Conditions of the Body and Diseases other than Tuberculosis," by Dr. F. Parkes Weber, on November 1; The Bradshaw lecture, on "Subtropical Esculents," by Dr. M. Grabham, on November 3; and the Fitz-Patrick lecture, on "Hippocrates in Relation to the Philosophy of his Time," by Dr. R. O. Moon, on November 8 and 10. The time in each case will be 5 o'clock.

THE autumn meeting of the Refractory Materials Section of the Ceramic Society is to be held at the Institution of Mechanical Engineers on Thursday and Friday, October 6 and 7, when the following papers will be read:—"Refractory Materials of the London Basin," H. Dewey; "The Marlow Gas-fired Tunnel Oven," J. H. Marlow; "A New Type of Tunnel Kiln, Oil-fired, with many Novel Features," P. J. Woolf; "Aluminothermic Corundum as Refractory Materials," Dr. A. Granger; and "The Reversible Thermal Expansion of Silica," Prof. J. W. Cobb and H. S. Houldsworth. There will also be a discussion on gas-firing.

THE secretary of the Royal Geographical Society has received a cablegram from Mr. J. M. Wordie, of St. John's College, Cambridge, announcing that the expedition of Mr. Wordie and Mr. Chaworth-Musters, of Caius College, to the Island of Jan Mayen this summer has been very successful, and that the first ascent of Beerenberg, the very summit of the island, has been made.

ACCORDING to the *Morning Post*, an expedition to Sumatra, under the leadership of Mr. C. Lockhart Cottle, is to sail towards the end of the year for the purpose of making zoological and museum collections. A special effort will be made to obtain particulars of the life-history of the orang.

A JOINT research committee has been formed by the National Benzole Association and the University of Leeds which will take over the direction of research in the extraction and utilisation of benzole and similar products in this country. The National Benzole Association is concerned with the production of crude and refined benzole, and, according to its constitution, one of its objects is to carry on, assist, and promote investigation and research. The term "benzole" is used in its widest sense, so the field of activity of the association embraces carbonisation and gasification processes, by-product coke-oven plants, gasworks, etc., but at the present time it is concerned mostly with the promotion of home production of light oil and motor spirit. Success in this direction is thought to rest largely with chemical investigations into the possibilities of the various processes concerned, and it is with this object that co-operation with the University is sought. The joint committee which has been formed consists of equal numbers of representatives from the University and the association, and the initial membership is as follows:—Prof. J. W. Cobb, Prof. J. B. Cohen, Prof. A. G. Perkin, Prof. Granville Poole, Prof. A. Smithells, Mr. W. G. Adam, Dr. T. Howard Butler, Mr. S. Henshaw, Mr. S. A. Sadler, and Dr. E. W. Smith. Research work undertaken will be carried out under the supervision of Prof. Cobb, and reports embodying the results will be published at intervals.

THE annual exhibition of the Royal Photographic Society was opened on Monday last at 35 Russell Square, W.C.1, and will remain open until October 29. Admission is free. The greatest novelty from a scientific point of view is a portrait of the Postmaster-General by M. Louis Lumière's new method of showing the solidity of solid objects by means entirely different from the ordinary stereoscopic method. Separate photographs are taken of, say, six different planes of the object, and the camera is so constructed that while the relative positions of the object, the lens, and the plate remain fixed so far as regards the plane being photographed, a movement of the plate and the lens renders unsharp the images in the other planes. Thin transparencies are then made from the negatives, and these are placed in properly spaced grooves one behind the other. A diffused light is arranged behind, and the whole is viewed, normally, from a distance of a yard or so. The result shown is strikingly good so far as the face is concerned, the definition being a little soft. The edge of the collar, where there is great contrast, shows a double or multiple image. Mr. Howard M. Edmunds illustrates a method of photo-sculpture. An image of an accurately drawn spiral line is projected by means of a lantern on to the face of the subject while a photograph is taken of him. A high-speed drill does the carving, and it is guided by "sighting a microscope attached to it on to" the special portrait described. A large series of photographs of spiders, butterflies, moths, etc., taken by flashlight without regard to the time of day or night except as the character of the subject renders necessary, is shown by Mr. Oswald James Wilkinson. The results are excellent, most of the pictures being life-size. There are many radiographs of great interest, astronomical photographs from Greenwich, two photographs of a waterspout by Mr. J. W. Knight, and innumerable other examples of good scientific work, besides the pictorial section. The society's museum, which has lately been enriched by a large quantity of apparatus used by Fox Talbot, is well worth a visit on its own account.

DURING the meeting of the British Association at Edinburgh Prof. W. D. Halliburton delivered a lecture on giants. He said that the popular conception of a giant was that he was a powerful, magnificent man, and very often used that power to the detriment of the races of mankind. As a matter of fact, a giant was a feeble and usually short-lived person, and destitute of the features associated with masculinity. It was

now established that certain organs, such as the thyroid gland and the pituitary body at the base of the brain, had vast potentialities and great value. Giganticism was due to the over-activity of the pituitary body from birth, or sometimes before it; but it occasionally happened that this over-activity came into play after the increase of height was no longer possible, and this was evidenced in an overgrowth of the extremities, which was technically called acro-megaly. It was very striking that portions of a man's brain could be removed, as was done in the recent war, but this tiny thyroid gland was of prime importance; its entire removal was followed by death within a very short time, and its over-activity or under-activity determined whether men were big or small.

At the Edinburgh meeting of the British Association Sir W. Ridgeway extended to totemism the theory of ancestral worship which he has applied, in his "Origin of Tragedy," to the investigation of the drama. A prominent part in its development has been played by transmigration, as in the case of the ancient Egyptians. Some Indonesians venerate the crocodile as a beneficent being, and look forward to becoming crocodiles after death, while tribes in Sumatra venerate tigers, supposing them to be their ancestors. Thus the reverence for certain trees, animals, etc., depends on the primary belief in the immortality of the soul. There can be no doubt, as some authorities stated in the course of the discussion which followed the reading of Sir W. Ridgeway's paper, that totemism is often found in connection with the cult of ancestors. But the difficulty remains that transmigration or the immortality of the soul does not seem to be one of the earliest and fundamental beliefs that arose in the human mind, and that totemism displays itself in many parts of the world as a complex form of belief, the varieties of which cannot easily be explained by any single theory of its origin.

In the September issue of *Man* Messrs. Buxton and Hort give an interesting account of the pottery industry of Malta, the facts having been collected during the visit of the Oxford Anthropological Expedition. Two methods, the old and the new, are in use. In the former method we have a baked clay support holding a wooden disc set spinning by the hand in a clockwise direction—a method occasionally used for making ollas, or large water-pots, but now falling into disuse. In the new method an iron spindle, with the point in the native rock-floor, is used, the lower disc being turned anti-clockwise with the foot, and the clay worked on the upper turn-table. This method has been in use only for about ten years, and one woman did not know how to work the modern wheel.

In the current issue (vol. 22, part 2) of the Records of the Indian Museum two entomological discoveries of unusual importance are put on record. The first is that of a dragon-fly of the genus Epiophlebia in the Himalayas. This genus, which appears to combine the characters of the Zygoptera and the Asisoptera, is an exceedingly archaic form, and has hitherto been known from a single Japanese species. A larva sufficiently advanced in development to be identified with certainty was found in a small collection from the Darjeeling district by Dr. F. F. Laidlaw, who, recognising its importance, has persuaded Dr. R. J. Tillyard to describe it in detail. The larva of this remarkable genus was hitherto unknown, and the extension of the geographical range from Japan to the Himalayas is a matter of great interest. The second discovery is that of a species of the termitophilous hemipterous genus Termitaphis on the east coast of India. The genus consists of curious flattened, wingless insects superficially resembling Coccidæ or Aphidæ, but conforming in structure to the Heteroptera. Species have hitherto been found in the warmer parts of North America, in South America, Australia, and West Africa, but not in the Oriental region. Prof. F. Silvestri, who describes the Indian form from a nest of *Coptotermes Heimi*, regards the genus as representing a distinct family, which he calls Termitocoridæ.

We have received the General Report of the Survey of India for the year 1919–20. Field-work still suffered from a shortage of officers, but this difficulty was being overcome. Topographical surveys during the year covered 30,464 square miles, including large areas in Upper Burma and Tenasserim. Among the new sheets published were 104 1-in. sheets, 39 ½-in. sheets, and 8 "degree" sheets. Two new sheets of the million map were produced, and practically the whole of India, Afghanistan, Persia, and parts of Burma are now published on this scale. No additions were made to the two-million series. The report includes indices to the maps of various scales.

Three papers in the Records of the Geological Survey of India (vol. 53, part 1, 1921) bear on the development of minerals of economic interest, but are in no case of a very hopeful nature. Dr. A. M. Heron describes lodes of antimonite 20 ft. wide south of Moulmein, Burma, in a district where labourers may be described as evanescent. Mr. H. C. Jones notes numerous occurrences of the same ore in the southern Shan States, none being of marked importance. Mr. G. H. Tipper gives a summary, from a recent journey, of "The Geology and Mineral Resources of Eastern Persia." Here the continuous destruction of forests has left no fuel for smelting ore. An interesting account is given of the long underground tunnels, often lined with glazed pipes, which convey water from the gravels for irrigating land lower down the slopes.

An important study of the origin of banded gneisses and amphibolites occurs in Mr. C. E. Tilley's paper on "The Granite-gneisses of Southern Eyre Peninsula, S. Australia" (Quart. Journ. Geol. Soc. London, vol. 77, p. 75, 1921). The production of the characteristic granular garnets and secondary pyroxenes of amphibolites from primary pyroxene, in a basic igneous rock invaded by granite, is excellently described. We may note again that in discussions of the banding of composite gneiss justice is rarely done to the work of Lévy, Lacroix, and Callaway (in Co. Galway), which dates back at least to 1887.

A MEMORANDUM has been issued under the direction of the Indian Government by Dr. Gilbert T. Walker, Director-General of Indian Observatories, on the rainfall of June and July and the probable amount during August and September, 1921. The monsoon appeared over the various parts of the country at about the normal times. The combined rainfall of June and July over the plains of India as a whole is said to have been nearly normal, the deficiency being only 1 in., or 5 per cent., but there was a deficiency of more than 20 per cent. in the United Provinces West, the Punjab east and north, the North-West Frontier Province, Baluchistan, Central India East, and Malabar. The memorandum gives the actual rainfall for the separate months June and July and the departure from the normal for the fifteen chief political divisions and the thirty-three sub-divisions of India. Details are given of the recent data regarding the conditions most likely to have influence on the rains of August and September, 1921; atmospheric pressure over India and the snowfall in mountain regions, as well as the meteorological conditions over the Indian Ocean and in other parts are discussed. From these conditions it is summarised that in North-West India, including the west of the United Provinces, and in the Peninsula, it is likely that the total rainfall of August and September will exceed the average. For North-East India and Burma the conditions are said to be too uncertain to justify a forecast.

ABOUT five years ago Prof. Omori made some interesting seismometric measurements of the movements of the great chimney at Saganoseki under the action of wind (NATURE, vol. 101, 1918, p. 436). It was found that the top of this chimney, 550 ft. in height, moved through a total range of 7¾ in. when the velocity of the wind was 78 miles an hour. The most interesting result of the measurements was that this movement took place at right angles to the direction of the wind. With the wind the range was always under 1 in. Prof. Omori has recently repeated these experiments on other columns (Bull. Imp. Earthq. Inv. Com., vol. 9, 1921, pp. 77–152). The most lofty is the reinforced concrete tower of the new wireless telegraph station of Haranomachi. This is a hollow, truncated cone, 660 ft. in height, with an external diameter of 57 ft. 9 in. at the base, and of 4 ft. 6 in. at the top, the thickness of the concrete wall being 33 in. and 6 in. respectively. The tower is situated about 200 km. from the principal earthquake zone off the east coast of Japan. The movements were registered by a portable two-component tremor-recorder magnifying from 10 to 30 times. Experiments were made at various times during the construction and after the completion of the tower, the maximum velocity of the wind varying from 20 to 45 miles an hour. It was found that the movements were quite insignificant until the height of the column was 290 ft., and they became distinct only when the height exceeded 500 ft. On completion, the maximum range (or double amplitude) was 6·9 mm., but this was increased to above 10·3 mm. when the iron frame, weighing more than two tons, was attached just below the top. The range of 6·9 mm. was attained in the direction perpendicular to that of the wind. With the wind the maximum range was only 1·9 mm. The period of vibration of the completed column was 2·07 seconds, or 2·12 seconds after the addition of the iron frame. Prof. Omori has also measured the vibrations of a twelve-story brick tower, 172 ft. high, at Tokyo, and of six five-story Buddhist pagodas in various parts of the country.

AT the Washington meeting of the American Physical Society in April last Prof. W. F. G. Swann, of the University of Minnesota, directed attention to the influence of the size of the earth on certain changes in terrestrial magnetism. The method of investigation is not exact from the mathematical point of view, but keeps the physical principles involved in the calculation clearly to the fore. In the first place, it is shown that electric currents once started in a copper sphere of the size of the earth would decrease to 37 per cent. of their initial value in 3,000,000 years. In the second, that if such a sphere were originally magnetised and means were then taken to demagnetise it, the same statement would hold for the magnetism. In the third place, if the so-called secular variation of the magnetisation be regarded as due to the rotation about the earth's axis once in 500 years of a uniform magnetisation perpendicular to that axis, the interior conductivity of the earth must be of the order 1/30,000 of that of copper. In the short paper in the issue of the Journal of the Washington Academy of Sciences for June 19, which is the only account of Prof. Swann's conclusions at present available, he points out that corresponding statements may be made with respect to the sun.

WITH reference to the inquiries made by Mr. Hedger Wallace in a letter entitled "Cornalith" published in NATURE of August 25, p. 811, we learn from Messrs. Erinoid, Ltd., of Lightpill Mills, Stroud, Gloucester, that cornalith and galalith are both trade names used by different firms for ivory and horn substitutes, etc. Galalith is the trade name for a casein-formaldehyde material manufactured by the Galalith Co. of Germany; cornalith is presumably the name selected by one particular firm to indicate that imitations of horn are their chief products. In England casein-formaldehyde products are manufactured and sold as raw material under the name of "erinoid," and Messrs. Erinoid, Ltd., claim that their output, nearly 700 tons, during the past year is far in excess of the combined output of both galalith and cornalith factories. The firm exhibited some of their products at the British Scientific Products Exhibitions organised in 1918 under the auspices of the British Science Guild. Vegetable casein has not so far proved as suitable as milk casein for the manufacture of casein-formaldehyde material, but if the Galalith Co. chose to send out an inferior product made from vegetable casein, there is nothing to prevent them from applying to it their own trade-name "galalith."

MESSRS. CHARLES BAKER, of 244 High Holborn, W.C.1, have issued recently a new classified list (No. 73) of second-hand scientific instruments and books. The catalogue contains a number of microscopes, of

wide range in size and price, and many object-glasses, eye-pieces, and other accessories are also listed. Surveying instruments, particularly theodolites and levels, are well represented. In the section devoted to telescopes, a number of second-hand instruments, both reflectors and refractors, on equatorial and altazimuth mounts, are offered for sale. The list includes a 12-in. reflector and a 12-in. and a $7\frac{1}{4}$-in. refractor, as well as several smaller instruments, object-glasses, eye-pieces, sidereal clocks, and other astronomical apparatus. A series of lantern-slides has been prepared to show the appearance of the bright line spectra between the limits 4000–7000 Å.U. of the commoner elements with normal dispersion. Slides of twenty-seven elements are now available; they should be of considerable service to science teachers. Other features of the catalogue are the sections dealing with cameras and other photographic apparatus and books; the latter contains, among a number of useful text-books and series of scientific periodicals, vols. 28 to 104 of NATURE.

THE Cambridge University Press is publishing the three following books in the autumn:—"New Mathematical Problems," by Major P. A. MacMahon; "Series Spectra," by Dr. Norman R. Campbell; and "Weather Prediction by Numerical Process," by L. F. Richardson. The first-named will be problems based on the permutations and combinations of elementary geometrical shapes; the second will be the first of the supplementary chapters to the author's "Modern Electrical Theory," to which allusion has already been made in NATURE (February 24, p. 842); and the third embodies a scheme of weather prediction, resembling the process employed in the production of the *Nautical Almanack*. At the close of the present year the same publishers will issue "Alternating Currents," in two parts, by C. G. Lamb. It is intended as a guide to the student attending a three-term course on the subject.

Our Astronomical Column.

SEPTEMBER METEORS.—Mr. W. F. Denning writes:—"An excellent series of abundant observations were obtained during the first ten days of the present month by Miss A. Grace Cook and Mr. J. P. M. Prentice at Stowmarket, and several hundred meteor paths were carefully recorded, from which a number of interesting radiant points were derived. These include various systems which have been well observed in past years, and several which apparently represent new showers.

"An active radiant of Orionids from $91\frac{1}{2}°+8\frac{1}{2}°$ was detected on September 1–3, which seems to have escaped previous observation; and among the old streams we observed were the ϵ Arietids, α Cassiopeids, α–β Perseids, and 1 Aurigids.

"Fireballs are usually very frequent in September, and the present month has proved no exception. Several brilliant meteors from Capricornus were observed on September 6, 7, and 14. On September 7 and 8 large meteors were seen from a radiant in Auriga, and on September 10 two brilliant objects were recorded, possibly from a radiant near α Cygni. The times of the two latter were at 9.10 and 11.40 G.M.T., and further observations of these various objects would be valuable. This display of Cygnids is a long-continued one, and was noted as specially active on September 12, 1918, as seen from Bristol."

IONISATION IN STELLAR ATMOSPHERES.—Dr. M. N. Saha has published an important series of papers on this subject in *Phil. Mag.* (vols. 40 and 41) and in Proc. Roy. Soc., 99 A (1921). A useful summary and *critique* of these is given by Mr. E. A. Milne in *Observatory* for September. The work consists of two parts: the study of the conditions of ionisation by the formulæ of physical chemistry, and an endeavour to explain some of the features of solar and stellar spectra in the light of the results. Taking calcium as an example, the percentage of ionisation at different temperatures and pressures is tabulated; the table indicates that at the surface of the sun both normal and ionised atoms of calcium should be plentiful, and, in fact, the *g*, H, K lines are all present. On the other hand, at great heights above the photosphere the pressure is small and ionisation almost complete; accordingly, only the enhanced lines H, K are visible here, *g* not being traced beyond a height of 5000 km. Analogous results are given for several other elements, and hope is held out that the method may eventually afford an indication of the pressure at various heights above the photosphere.

Lessons are also deduced from the progressive appearance and disappearance of certain lines as we pass along the series of stellar spectra from M to O. Dr. Saha determines the temperature of each type, his values ranging from 23,000° Oa, 18,000° Bo, to 5000° Ma, and 4000° Md. These are in fair accord with those of Russell, Wilsing, and Scheiner, but slightly higher on the average.

It will be remembered that several astronomers have suggested that, the supply of gravitational energy being insufficient to maintain their output, the stars are drawing on the energy of the atom. It is likely, therefore, that atomic chemistry will play an important part in the astronomy of the future.

VARIABLE STARS.—Observations of seventy-two well-known variable stars, the R.A.'s of which range from 5h. 21m. to 24h., were made by Prof. Vojtěch Šafařík at Prague between the years 1877 and 1894. They are reproduced in great detail by Prof. Ladislav Pračka in a publication recently received ("Untersuchungen über den Lichtwechsel Älterer Veränderlicher Sterne. Nach den Beobachtungen von Prof. Dr. Vojtěch Šafařík." Vol. 2, pp. iii+180. Prag: Fr. Řivnáč, 1916). The magnitudes of the comparison stars are discussed and compared with all available authorities; the differences of magnitude between them and the variables are given in full, and the nature of the light curve, with the dates of maximum and minimum, is discussed in all cases where the observations suffice for the purpose. There are also many estimates of colour, on Schmidt's numerical scale, which represents white by 0, yellow by 4, orange by 7, red by 9 to 10. The long-period variables in this volume are without exception orange or red; eleven of them have colour-estimates extending beyond 9, and one star, S Cephei, has a colour-estimate of 10.

The following stars have especially long and full series of observations: R Leonis, R Camelopardi, R Draconis, R Aquilæ, U Cygni, V Cygni, S Cephei. Observations of two novæ are included in the volume. Nova Aurigæ fell from 5m. to 11m. in a few weeks early in 1892, then revived to 9·2m. early in 1893, being 9·9m. at the end of that year. Nova T Coronæ appeared to remain steady at 9·2m. during the years 1886 to 1894.

Spontaneous Combustion in Coal Mines.

THE final report of the Departmental Committee appointed by Mr. McKenna in 1912 "to inquire into the circumstances in which spontaneous combustion of coal occurs in mines, its causes and the means of preventing it or of dealing with it," has now been issued.[1]

In form it is a model of what such a report should be; it opens with an historical review of the subject from the seventeenth century, it proceeds to summarise and analyse the scientific evidence collected during the last ten years, and then considers the conditions which are found in practice to be conducive to spontaneous ignition in coal-mines and the means of preventing or extinguishing such fires.

The question whether coal can ignite *per se*, or whether this is effected through the heating of an impurity, *e.g.* iron pyrites, has long been in dispute, the older opinion, both among practical men and chemists, inclining strongly to the view that the oxidation of pyrites is the primary cause of the ignition.

In an interesting quotation from Dr. Plott's "Natural History of Staffordshire" (1686) we learn that the shale and small coal left in the hollows of old workings will fire "natural of themselves," and "have done beyond all memory." The seat of the heating is said to be a mixture of the "laming," that lies between the measures of the coal, and the "sleck" when "very much mixed with brass lumps." Plott evidently leans to the pyrites theory, and quotes Dud Dudley and Dr. Powers as vouching for the statement that small coal and sulphurous sleck when moistened and exposed to the air will turn red-hot of themselves. The experience of mining engineers, who found as a fact that fires mainly occurred in seams rich in pyrites (as in South Staffordshire) and were absent in coalfields (such as the Durham field) where the pyrites is very low—backed as this experience was by the authority of chemists from Berzelius to Liebig—led to the almost universal belief in pyrites being the sole cause of ignition. Dr. Percy in 1864 seems to have been the first to suggest that coal could itself absorb oxygen and become heated, and this view received much support from the experiments of Dr. Richters, of Waldenburg, who showed that fine coal with very little pyrites in it would absorb oxygen and heat up, while the pyrites itself showed very small absorption. The Royal Commission appointed in 1876 to inquire into the spontaneous combustion of coal in ships regarded pyrites as the primary cause, but found that the condensation of oxygen on the surface and the subsequent oxidation of the coal matter were "contributory" causes.

Since that date experiments in France, mainly those of Henri Fayol, and in Germany on the seams of Upper Silesia (where fires are frequent), have shown that the condensation and absorption of oxygen from moist air by coal itself—especially when the coal is in a thick layer—are the important factors in spontaneous combustion, while the oxidation of pyrites (marcasite) is a less important factor. Up to the end of the last century we may say that the pyrites theory had the larger following; but since the report of the German Commission in 1910 scientific opinion has changed, and the opinion of practical men has been doubtful.

The verdict of the Committee—a body of men practically familiar with coal-mining—that they are satisfied on the scientific evidence brought before them that coal subject to spontaneous firing owes this property, not to its pyrites content, but to the direct oxidation of the coal matter, should set at rest all reasonable doubt and concentrate attention on the real cause. That some heat may be generated by the oxidation of marcasite is admitted, but its direct effect is negligible. Where pyrites may play a part is in the disintegration of coal whereby the latter may become more permeable by air, and so more readily oxidised.

In arriving at their conclusions the Committee was largely influenced by the experimental work of Prof. Bedson, Sir R. Threlfall, Dr. Wheeler, and Dr. Haldane, who were in close agreement; and where there still appeared to be some doubt, *e.g.* in the case of the Bullhurst seam (North Staffordshire) and in that of the Barnsley seam (Yorkshire), the Committee requested Dr. Wheeler to carry out special experiments for them. These experiments are quoted in full and appear conclusive. The Committee directs attention to Dr. Wheeler's statement that the higher the oxygen content of a coal the lower is its temperature of self-ignition, and emphasise the practical importance of the fact that a coal containing more than 10 per cent. of oxygen is liable to inflammation—or, at all events, is suspect—whereas a coal containing less than 6 per cent. may be regarded as non-suspect.

It is interesting to note that the work of the palæobotanists is not neglected, and that the "fusain" of Dr. Marie Stopes—the mother-of-coal—(shown by her to be woody fibre) forms at its juncture with "vitrain"—glance coal—the critical point of any piece of coal with regard to inflammation—a conclusion which recalls Dr. Plott's statements as to the mixture of "laming" with "sleck."

The remaining sections of the report deal with the practical aspects of the subject, and give many technical suggestions for preventing and dealing with gob-fires. One of the most important points discussed is the practicability of hydraulic stowage—a certain cure if it could be worked.

[1] Departmental Committee on Spontaneous Combustion of Coal in Mines. Final Report of the Departmental Committee on Spontaneous Combustion of Coal in Mines. (Cmd. 1417). (London: H.M. Stationery Office.) 1s. 6d.

Lighting of Factories and Workshops.

IN 1913 a Departmental Committee was appointed by the Home Secretary to inquire into the lighting of factories and workshops. The Committee issued in 1915 an interim report containing much valuable information which attracted much attention and still holds a unique position amongst official literature on this subject. On that occasion statutory provisions requiring adequate and suitable lighting in every part of a factory and workshop were recommended. Values of illumination were also prescribed in the interests of safety and convenience, but detailed recommendations on the order of illumination necessary for various industrial processes were deferred.

The work of the Committee, suspended during the later stages of the war, was resumed in 1920, and a second report defining with greater precision the phrase "suitable lighting" has recently been issued (Cmd. 1418. 1d. net). The report deals specially with the three factors of glare, shadow, and constancy.

Glare may arise through the presence of unduly bright lights in the direct field of vision or on the edge thereof, or through inconvenient direct reflection of light from shiny or polished material. Four requirements bearing on the above points are now suggested :—

(1) Every light source (except one of low brightness [1]) within a distance of 100 ft. from any person employed shall be so shaded from such person that no part of the filament, mantle, or flame is distinguishable through the shade, unless it be so placed that the angle between the line from the eye to an unshaded part of a source and a horizontal plane is not less than 20°, or in the case of any person employed at a distance of 6 ft. or less from the source not less than 30°.

(2) . . . "Adequate means shall be taken, either by suitable placing or screening of the light sources, or by some other effective method, to prevent direct reflection of the light from a smooth or polished surface into the eyes of the worker."

(3) . . . "Adequate means shall be taken to prevent the formation of shadows which interfere with the safety or efficiency of any person employed."

(4) . . . "No light sources which flicker or undergo abrupt changes in candle-power in such manner as to interfere with the safety or efficiency of any person employed shall be used for the illumination of a factory or workshop."

In view of the fact that extensive alterations may be occasioned by compliance with these requirements, it is further prescribed :—

(5) "That, as regards existing installations, a reasonable time limit should be given before the above requirements become operative."

An appendix to the report contains extracts from codes adopted in various American States and recommendations made by the Illuminating Engineering Society in Germany.

[1] *I.e.* with an intrinsic brilliance not exceeding 5 candles per sq. in.

The World's Wheat Supply.

THE statistics dealing with the wheat supply of the world are discussed by Sir James Wilson in an interesting and exhaustive paper entitled "The World's Wheat," contributed to the Journal of the Royal Statistical Society (vol. 84, part 3, May, 1921).

Having pointed out the varying accuracy of available statistics and explained the system of calculation adopted, the author gives the pre-war five-year average yields for all wheat countries, together with the exports and imports. For this period the world's yield was 107 million metric tons, of which 22·2 million metric tons—more than one-fifth of the whole—were produced by Russia. The net world exports amounted to 18·5 million metric tons, of which Russia again contributed the largest proportion, nearly one-fourth of the whole; while of the net imports of 18·0 million metric tons Great Britain was the largest importer with 5·9 million metric tons, followed by Germany with 1·9 million metric tons. Naturally, these figures were all profoundly affected by war conditions. Statistics are not available for such important countries as Germany, Austria, and Belgium among the importers, nor for Russia, Rumania, Hungary, and Bulgaria among the exporters, but for the twenty-one countries where figures have been published the average yield was 66·8 million metric tons during the war, compared with 63·1 million metric tons before the war. The importing countries on the average produced less than before the war, but they also imported less. Britain increased her average yield from 1·6 to 1·9 million metric tons and reduced her average net import from 5·9 to 5·2 million metric tons and her average consumption from 7·5 to 7·1 million metric tons. The exporting countries—United States, Canada, and Argentina—all increased their yields considerably, and also their exports. Australia increased her yield, but her average export was much the same as the pre-war average, probably on account of the large loss of stored wheat by mice and weevil depredations. India's average yield during the war was practically the same as the pre-war average, but owing to the export restrictions enforced by the Government in the interests of the consumers her average net export fell from 13·5 million metric tons before the war to 8·2 million metric tons during the war period.

With regard to the supplies of 1919 and 1920, excluding Russia and Rumania (which in the pre-war average exported nearly one-third of the world's net exports) and India (export from which country was practically prohibited), the other exporting countries began the cereal year on August 1, 1919, with about 6·1 million metric tons of exportable supplies still in hand, while there was also a large quantity on its way to the importing countries. All the importing countries together in 1919–20 imported 18·2 million metric tons, which is about the pre-war average, and during that year the Argentine and Australia got rid of their embarrassing surplus, while towards the end of the year the United States had practically a monopoly of export, and so obtained very high prices. Sir James Wilson estimates that for the current year ending July 31, 1921, there will be 18·9 million metric tons available to meet the estimated demand of 17·0 million metric tons, which will leave a sufficient, though not excessive, margin on the eve of the ripening of the new harvests in the northern hemisphere.

It is to the temporary advantage of consumers that there should be an excess of supply over demand, and to the temporary advantage of producers that the demand should exceed the supply; but for the world as a whole it is better that supply and demand should approximate. In the author's opinion, from the information available at the time, this condition should be reached as regards wheat on August 1, 1921, and according to present prospects (excluding Russia, Rumania, and India) the harvest to be reaped after that date will yield sufficient to meet the world's probable demands. For the more distant future fears are sometimes expressed that the growth of the world's population, and especially of the number of wheat-eaters, will result in a permanent dearth of wheat, but it must be remembered that the great majority of mankind prefer grains other than wheat, and even the wheat-eaters substitute other grains without much sense of hardship.

With regard to wheat prices, in most European countries at the present day the high prices of wheat are largely due to the depreciation of the various paper currencies. The author discusses the different factors which will affect the wheat prices—rates of exchange, freight charges, etc.—and concludes that, so far as Britain is concerned, the price of wheat will be lowered if "the rate of exchange with the United States of America improves, and if Asia and South America continue to absorb gold at a great rate, and so help to reduce the prices of all commodities, measured in gold, all the world over."

University and Educational Intelligence.

LONDON.—The following special advanced lectures have been arranged at King's College for post-graduate and other advanced students. The dates given are those on which the courses begin :—"Liquid Fuels," Mr. Harold Moore, October 17; "Liquid Fuel Engines," Dr. W. R. Ormandy, October 24; "Bridge Construction," Mr. H. W. FitzSimons, October 13; "Cascade Induction and Synchronous Motors and Generators," Mr. L. J. Hunt, October 18; "Reinforced Concrete," Dr. Oscar Faber, January 19, 1922; "Accurate Measurements in Mechanical Engineering: The Use and Testing of Gauges," Mr. F. H. Rolt, January 24; "Wireless Transmitting Valves," Prof. C. L. Fortescue, January 23; and "The Cheapening of Electrical Energy in Great Britain," Mr. C. H. Wordingham, February 27.

OXFORD.—Mr. J. H. Jeans, secretary to the Royal Society, has been appointed Halley lecturer for 1922.

BIRMINGHAM.—By the retirement of Mr. W. H. Cope, the University librarian, the University loses a valuable servant whose place will be difficult to fill. In forty years of strenuous and whole-hearted devotion to duty Mr. Cope has brought the rapidly growing library to a state of efficiency out of all proportion to the expenditure involved. Regardless of the fact that his salary was a mere pittance and that the library was deplorably understaffed, he always gave of his best; and by his ever-ready assistance he earned the gratitude of many generations of staff and students whose good wishes will follow him into his retirement.

THE Herter lectures are to be delivered at Johns Hopkins University, Baltimore, on October 5, 6, and 7 by Sir Arthur Keith, who will take as his subject "The Differentiation of Human Races in the Light of the Theory of Hormones."

DR. D. BURNS, Grieve lecturer on physiological chemistry in the University of Glasgow, has been appointed professor of physiology in the University of Durham College of Medicine, Newcastle-upon-Tyne, in succession to the late Prof. J. A. Menzies.

AMONG the free public Gresham lectures shortly to be delivered at Gresham College are the following :—Physic, Sir Robert Armstrong-Jones, October 11, 12, 13, and 14; Astronomy, Mr. A. R. Hinks, October 18, 19, 20, and 21; and Geometry, Mr. W. H. Wagstaff, November 7, 8, 10, and 11. The lecture-hour is 6 o'clock.

THE Prospectus of University Courses in the Municipal College of Technology, Manchester, for the session 1921–22 has recently been issued. Systematic training extending over a period of three or four years is provided in mechanical, electrical, municipal, and sanitary engineering, the technology of the chemical and textile industries, photography and printing, etc. University courses leading to the degrees of Bachelor and Master of technical science in these subjects are available, and, in addition, there are numerous part-time day and evening courses for the benefit of engineers, apprentices, and others who cannot attend for full-time instruction. In conjunction with the Students' Union there is a technical section consisting of the Chemical, Engineering, and Textile Societies, the objects of which are to discuss technical subjects of interest to the members and to arrange for periodical visits to works and factories. These visits serve to amplify the generous arrangements made in the college itself for practical work in the laboratories.

Calendar of Scientific Pioneers.

September 22, 1703. Vincenzo Viviani died.—The last pupil of Galileo, Viviani took a prominent place among the geometers of the seventeenth century, and became mathematician and chief engineer to the Grand Duke of Tuscany.

September 22, 1874. Jean Baptiste Armand Louis Léonce Elie de Beaumont died.—Professor of geology in the Collège de France and successor to Arago as permanent secretary of the Paris Academy of Sciences, Elie de Beaumont had a leading share in the geological survey of France, and among his best-known works are those relating to the age and origin of mountain systems.

September 23, 1738. Hermann Boerhaave died.—The most famous physician of his day, Boerhaave as a professor of botany, medicine, and chemistry raised the University of Leyden to the summit of its fame. His writings were translated in many languages.

September 23, 1877. Urbain Jean Joseph Leverrier died.—Sharing with Adams the honour of the discovery of Neptune, Leverrier was one of the greatest French astronomers of last century. He succeeded Arago as director of the Paris Observatory, where he carried out the complete revision of planetary theories and the formation of new tables.

September 23, 1882. Friedrich Wöhler died.—Born in 1800, Wöhler while a teacher in the Berlin Trade School first prepared the metal aluminium, and in 1828 effected the synthesis of urea. He collaborated with Liebig, and, like him, was a great teacher. From 1836 he held the chair of chemistry at Göttingen.

September 24, 1541. Paracelsus died.—A remarkable figure in the annals of science, Paracelsus—or Theophrastus Bombastus von Hohenheim—was the contemporary of Copernicus and Luther. An erratic genius of extraordinary insight, but notorious habits, he was a leader in the revolt against authority which marked the beginning of modern scientific progress.

September 25, 1777. Johann Heinrich Lambert died.—One of the group of learned men attracted to Berlin by Frederick the Great, Lambert enriched both mathematics and astronomy by his researches and discoveries.

September 26, 1703. Johann Christoph Sturm died.—Sturm has been called the restorer of the physical sciences in Germany. He was for many years at the Academy of Altdorf, and persistently advocated the introduction of science into the schools of Germany.

September 26, 1868. August Ferdinand Möbius died.—Holding the chair of higher mathematics and astronomy at Leipzig, Möbius was regarded as one of the leaders in modern projective geometry.

September 27, 1908. John Macon Thome died.—As assistant and successor to Gould at the Cordoba Observatory, Thome did much for astronomy in South America.

September 28, 1895. Louis Pasteur died.—Honoured as a benefactor of mankind, Pasteur was a great chemist and a great biologist. He was drawn to the study of chemistry by the lectures of Dumas, and became a professor first at Strassburg, then at Lille, and in 1867 at the Sorbonne. The Pasteur Institute in Paris contains his tomb, and his record of services is inscribed upon it thus :—

"1848, Molecular dissymmetry. 1857, Fermentations. 1862, Spontaneous generation. 1863, Studies on wine. 1865, Silkworm diseases. 1871, Studies on beer. 1877, Contagious diseases of animals. 1880, Vaccination against contagious diseases. 1885, Prevention of hydrophobia." E. C. S.

Societies and Academies.

PARIS.

Academy of Sciences, August 22.—M. Léon Guignard in the chair.—J. K. **de Fériet**: Hypergeometric functions of higher order with two variables.—R. **Serville**: The tangential and radial resistance of a turning body. Application to the isochronism of the conical pendulum by a central force.—K. **Ogura**: The movement of a particle in the field of a charged nucleus.—St. **Procopiu**: The depolarisation of light by liquids holding crystalline particles in suspension. Depolarisation is practically *nil* for pure liquids, very small for non-crystalline suspensions or for substances crystallising in the cubic system, and large for doubly refracting suspensions. A solution of ferric chloride is strongly depolarising, suggesting that the colloidal particles are crystalline and doubly refracting.—P. **Dejean**: The transformation of iron at the Curie point. From the experiments described it is concluded that the apparent discontinuity produced in the magnetic qualities at the Curie point can be explained by a continuous action, either the progressive transformation of an α form into a β form, or, more simply, the progressive separation of the elementary magnets by the gradual rise of temperature.—M. **Bridel** and Mlle. Marie **Braecke**: The presence of a glucoside hydrolysable by emulsin in two species of the genus Melampyrum. These plants blacken on drying, and this is shown to be due to the presence of a glucoside. This glucoside, on hydrolysis, gives a black insoluble substance. It is possible that the glucoside is aucubine.—M. **Bezssonoff**: The anti-scorbutic principle in potato-juice extracted in presence of acids. The juice extracted from potatoes by pressure possesses a very small antiscorbutic action. As it was thought probable that the antiscorbutic principle might under these conditions have been destroyed by laccase, a small proportion of citric acid was incorporated with the potato before applying pressure. The acidity in the juice thus obtained was sufficient to inhibit the oxidising action of the laccase, and it was found that the antiscorbutic action of this expressed potato-juice was much higher than that expressed without the addition of acid.—J. **Mascart**: Weather forecasts for long periods.—J. **Politis**: The *rôle* of the chondriome in the defence of the plant against parasitic invasion.—H. **Ricome**: The orientation of the stem.—St. **Jonesco**: Anthocyanidines in the free state in the flowers and red leaves of some plants. Proof that this red pigment exists in the free state in red organs of plants.—A. **Kozlowski**: Saponarine in *Mnium cuspidatum*.

September 5.—M. Georges Lemoine in the chair.—S. **Banach**: Ensembles of points the differential coefficient of which is infinite.—J. **Grialou**: The irrotational and permanent movement of a liquid, the trajectories being vertical and plane and the *régime* permanent.—A. **Lumière** and H. **Couturier**: The relations between the anaphylactic shock and the introduction of precipitates into the circulation. The experiments of Arthus on the introduction of an emulsion of beeswax into the veins gave results which appear to contradict the physical theory of shock put forward by the authors. Additional experiments with the wax emulsion are described, showing that this can also cause anaphylactic shock if injected into the left ventricle of the heart. The authors regard the experiments of Arthus as affording additional confirmation of their views as to the cause of shock.—J. **Pottier**: Observations on the chromatic masses of the nuclei and of the cytoplasm of the cells of the canal and of the wall of the neck of the archegonium in *Mnium undulatum*.—N. **Bezssonoff**: A colour reaction common to antiscorbutic extracts and hydroquinone. The author describes a modification of the Folin-Denis phenol reagent which gives a blue coloration with plant extracts known to possess antiscorbutic power and no coloration, or colour not blue, with plant extracts devoid of antiscorbutic power. It is not regarded as proved that the blue colour is due to the antiscorbutic substance, since it may be caused by a polyphenol split off in solution from the vitamin C. Of the numerous phenols tested the only one giving the same blue colour proved to be hydroquinone.

EDINBURGH.

Royal Meteorological Society, September 7.—Mr. R. H. Hooker, president, in the chair.—R. H. **Hooker**: The functions of a scientific society, with special reference to meteorology. The main functions of a society are the discussion of discoveries, the formation of a library, and the printing of technical papers. In spite of the increase in Government institutions undertaking original scientific investigations, there are more scientific experts outside Government service than in it, and the latter find the society a necessary means of inter-communication in order to keep abreast of the times. The spread of science among the greatest number of people is one of the most important objects of the society. The recent amalgamation of the Royal and Scottish Meteorological Societies might appear to curtail the opportunities of Scottish fellows, but the present session in Edinburgh was intended to be the forerunner of others. Also, local meetings could be held at any centre where there were a sufficient number of fellows within reach.—Dr. A. **Macdonald**: Meteorology in medicine, with special reference to the occurrences of malaria in Scotland. The fundamental meteorological factor influencing biological reactions is temperature. This influence is universal in its application to organic life, and has specific implication in the production of disease. The *rôle* of temperature in the manufacture of diseases due to the parasitic protozoa is dealt with in a consideration of the temperature limitations of the development of the sexual phase of the plasmodia of malaria in the anopheline mosquito. The history of the occurrence of malaria (ague) in Scotland is studied in relation to temperature conditions that have prevailed since early in the eighteenth century. Actual recorded outbreaks are shown to coincide with abnormal high temperature over several months in consecutive years. Wars have been the main factor in the introduction of malaria infection, which, although powerless to establish the disease endemic in Scotland, will produce an outbreak when importation in large volume coincides with a mean temperature of 60° F. continued over a period.—Dr. A. Crichton **Mitchell**: The diurnal variation of atmospheric pressure at Castle O'er and Eskdalemuir Observatory, Dumfriesshire. The hourly values of atmospheric pressure recorded at Eskdalemuir Observatory during the ten years 1911–20 have recently been reduced, and a comparison with those obtained by Dr. C. Chree from the Castle O'er barograph records during 1902–8 show very considerable differences, although the stations are close together. These differences are probably due to unsuitable exposure of the Castle O'er instrument and to its imperfect temperature compensation.—Dr. S. **Fujiwhara**: The natural tendency towards symmetry of motion and its application as a principle in meteorology. "Any revolving system in Nature tends towards symmetry within the limit of its freedom." A special case of this principle is that "when any revolving fluid lies near to a plane boundary its axis tends to become normal to that boun-

dary." Many examples supporting the above principle have been obtained from meteorological observations, and synthetically the universal existence of the above proposition is assumed. It is suggested that the present principle must be derived from "the principle of equality."—C. J. P. **Cave**: Some notes on meteorology in war-time.

Books Received.

An Experiment in Synthetic Education. By Emily C. Wilson. With Chart for Five Years' Work. Pp. 62. (London: G. Allen and Unwin, Ltd.) 4*s.* 6*d.* net.

Twenty-five Years in East Africa. By Rev. J. Roscoe. Pp. xvi+288+19 plates. (Cambridge: At the University Press.) 25*s.* net.

Treatise on Fractures in General, Industrial, and Military Practice. By Prof. J. B. Roberts and Dr. J. A. Kelly. Second edition, revised. Pp. x+755. (Philadelphia and London: J. B. Lippincott Co.) 42*s.* net.

Biological Chemistry. By Prof. H. E. Roaf. Pp. xvi+216. (London: Methuen and Co., Ltd.) 10*s.* 6*d.* net.

The Fourth Dimension Simply Explained: A Collection of Essays Selected from those Submitted in the *Scientific American's* Prize Competition. By Dr. H. P. Manning. Pp. 251. (London: Methuen and Co., Ltd.) 7*s.* 6*d.* net.

Geofysiske Publikationer, vol. 1, No. 1. The Position in Space of the Aurora Polaris, from Observations made at the Haldde Observatory, 1913–14. By L. Vegard and O. Krogness. Pp. vii+172+plates. (Kristiania: A. W. Brøggers.)

Annales de l'Observatoire astronomique de Tokyo. Tome 5, 4 fascicule: Studies on Astronomical Timekeepers and Time-preserving Systems. By Kiyofusa Sôtomé. Pp. ii+59. (Tokyo: Imperial University.)

New Zealand. Department of Mines: Geological Survey Branch. Palæontological Bulletin, No. 8: Lists of New Zealand Tertiary Mollusca from various Localities Examined and Named from 1913 to the End of 1917. By H. Suter. Pp. vii+107. (Wellington.)

Die Tagebücher von Dr. Emin Pascha. Herausgegeben von Dr. Franz Stuhlmann. Band VI., Zoologische Aufzeichnungen Emin's und seine Briefe an Dr. G. Hartlaub, bearbeitet von Prof. Dr. H. Schubotz. Pp. viii+301. (Hamburg und Braunschweig: G. Westermann.) 200 marks.

The Advancement of Science: 1921. Addresses Delivered at the 89th Annual Meeting of the British Association for the Advancement of Science, Edinburgh, September, 1921. (London: J. Murray; The British Association.) 6*s.* net.

A Short Course in Commercial Arithmetic and Accounts. By A. Risdon Palmer. (Bell's Mathematical Series.) Pp. x+171+xv. (London: G. Bell and Sons, Ltd.) 2*s.* 6*d.*

The Use of Graphs in Commerce and Industry. By A. Risdon Palmer. (Handbooks of Commerce and Finance). Pp. ix+47. (London: G. Bell and Sons, Ltd.) 2*s.* net.

Practical Mathematics. By A. Dakin. Part 1. Pp. viii+362+12+xxiv. (London: G. Bell and Sons, Ltd.) 5*s.*

Index Kewensis Plantarum Phanerogamarum. Supplementum Quintum Nomina et Synonyma Omnium Generum et Specierum ab Initio Anni MDCCCCXI Usque ad Finem Anni MDCCCCXV Nonnulla Etiam Antea Edita Complectens. Ductu et Consilio D. Prain, Confecerunt Herbarii Horti Regii Botanici Kewensis Curatores. Pp. iii+277. (Oxonii: E Prelo Clarendoniano.) 76*s.* net.

Memoirs of the Geological Survey. Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for 1920. Pp. iv+112. (London: E. Stanford, Ltd.; Southampton: Ordnance Survey Office.) 3*s.* 6*d.* net.

Memoirs of the Geological Survey: Scotland. The Economic Geology of the Central Coalfield of Scotland. Area IX., Carluke, Strathaven, and Larkhall, with Braidwood, Netherburn, Auchenheath, Blackwood, and Stonehouse. By L. W. Hinxman and others. Pp. viii+148. (London: E. Stanford, Ltd.; Southampton: Ordnance Survey Office.) 8*s.* net.

The Continents of the South. By A. B. Archer. (A Secondary School Course in Geography, Book II.) Pp. xvi+272. (London: W. Heinemann.) 4*s.* 6*d.* net.

Soil Conditions and Plant Growth. By Dr. E. J. Russell. (Rothamsted Monographs on Agricultural Science.) 4th edition. Pp. xii+406. (London: Longmans, Green and Co.) 16*s.* net.

The Physical Properties of Colloidal Solutions. By Prof. E. F. Burton. (Monographs on Physics.) 2nd edition. Pp. viii+221. (London: Longmans, Green and Co.) 12*s.* 6*d.* net.

The Transition Spiral and its Introduction to Railway Curves: With Field Exercises in Construction and Alignment. By Arthur L. Higgins. Pp. viii+111. (London: Constable and Co., Ltd.) 6*s.* net.

Diary of Societies.

WEDNESDAY, SEPTEMBER 28.

FARADAY SOCIETY (at Institution of Electrical Engineers), at 4.30.—General Discussion on Catalysis, with Special Reference to Newer Theories of Chemical Action. Part 1, The Radiation Theory of Chemical Action, opened by Prof. J. Perrin. Part 2, Heterogeneous Reactions, opened by Prof. I. Langmuir. Expected speakers:—Prof. Arrhenius, Prof. V. Henri, Prof. E. C. C. Baly, Prof. F. G. Donnan, Prof. W. C. McC. Lewis, Prof. A. Lindemann, Prof. A. W. Porter, and Dr. E. K. Rideal.

CONTENTS.

	PAGE
Causes of Fluctuations in the Birth-rate	105
Indian Land Mollusca. By Lt.-Col. H. H. Godwin-Austen, F.R.S.	106
Chemistry of Anthracene. By Dr. M. O. Forster, F.R.S.	108
The Future of Geometrical Optics. By L. N. G. F.	109
Kite Balloons. By Dr. S. Brodetsky	111
Our Bookshelf	111
Letters to the Editor:—	
Communism and Science.—Dr. J. W. Mellor	113
The Disaster to the Airship R38. — Dr. Wm. Leighton Jordan; The Writer of the Article	114
The British Association in Edinburgh. By C. G. K.	115
Science and Crop Production. (*With Diagrams.*) By E. J. Russell, D.Sc., F.R.S.	116
Applied Geography. By D. G. Hogarth, M.A., D.Litt, C.M.G.	120
Stellar Parallax. By J. Jackson	124
Obituary:—	
John Robert Pannell. By N. R. C.	127
Notes	127
Our Astronomical Column:—	
September Meteors	131
Ionisation in Stellar Atmospheres	131
Variable Stars	131
Spontaneous Combustion in Coal Mines	132
Lighting of Factories and Workshops	132
The World's Wheat Supply	133
University and Educational Intelligence	134
Calendar of Scientific Pioneers	134
Societies and Academies	135
Books Received	136
Diary of Societies	136

THURSDAY, SEPTEMBER 29, 1921.

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The Explosion at the Nitrogen Fixation Works, Oppau.

ON the morning of September 21 an explosion causing enormous damage occurred at the nitrogen fixation works of the Badische Anilin und Sodafabrik at Oppau, near Ludwigshafen, on the Rhine. The town of Oppau has been entirely wrecked and presents the appearance of war-devastated ruins, and the neighbouring village of Edigheim has met with the same fate. Numbers from 500 to 2000 are given as estimates of the killed, and the other casualties must be very large. It is stated that the explosion was felt 175 miles away at Munich. Photographs which have come to hand of the scene of the disaster show a huge crater.

The history of the works at Oppau is of great interest, and their importance to Germany was supreme during the war, for it was there that synthetic ammonia was produced in enormous quantities sufficient, together with ammonia from another synthetic source and from gas works, to enable Germany to obtain nitric acid for the manufacture of high explosives, when the supply of Chile saltpetre, the former source of that acid, had been cut off by the Allies.

The experimental work on the combination of nitrogen and hydrogen carried out by Haber and his colleagues at Carlsruhe had been closely watched and partly subsidised by the Badische company, which ultimately took over the process, and after a trial in an existing factory it erected the works at Oppau shortly before the war to operate the Haber-Bosch process. The necessity for fixing nitrogen from the air after the first set-back to the German attack brought about a large extension of these works, until, it is stated, about 200 tons of ammonia a day were produced there. The magnitude of this technical achievement is apparent when one considers the enormous volumes of hydrogen and nitrogen that had to be prepared and purified, the mechanical and chemical difficulties that had to be overcome in bringing about their combination under heat and pressure in large steel bombs charged with a catalyst, and the complexity of the contingent plant for movement of gases and liquids and for absorption and concentration. Many millions sterling were expended on the construction of the plant, which required several thousands of skilled workers to operate it.

The ammonia thus formed was largely converted into nitric acid by the Ostwald-Mittasch method during the war, but since then it has been used for the manufacture of fertilisers, such as ammonium sulphate and ammonium nitrate. The formation of ammonium nitrate is particularly favourable, as it involves oxidation of only a portion of the ammonia to nitric acid. The Germans claim to have overcome the difficulties of the application of this hygroscopic salt for agricultural purposes, and to have had good results from its use.

In addition to the Oppau factory, a still larger one operating on the same lines has been erected at Merseburg, in central Germany, capable, it is said, of producing 800 tons of ammonia a day.

While the cause of the disaster will no doubt be fully investigated, the significant statement is attributed to one of the directors that the explosion must have taken place in a store of "ammonium sulphate saltpetre." Presumably a store of ammonium nitrate (Ger. ammonsalpeter) with or without admixture with ammonium sulphate is meant. In another account the quantity of this material is given as 4000 tons. Although ammonium nitrate was used in very large quantities in this country during the war for mixing with trinitrotoluene to form amatol, no accidents occurred in handling it. Circumstances have, however, occurred, mostly elsewhere, that have thrown some suspicion on its being quite innocuous from the point of view of danger; but to bring ammonium nitrate, which is an explosive body, up to the pitch of violent explosion or detonation requires the application of a very intense initial impulse. This has been done by detonating

in its midst a high explosive, and a comparative measure of the violence of ammonium nitrate itself and of its mixtures with trinitrotoluene was quoted in a recent lecture to the Chemical Society. The appearance of the crater formed in the Oppau explosion is reminiscent of the effect of the detonation of a large quantity of explosive, and the result of the inquiry into the cause of the disaster is awaited with much interest. The factory is in the zone occupied by the French, and medical and other assistance is being rendered by them and by the other Allied troops on the Rhine.

Applied Chemistry.

(1) *An Introduction to the Chemistry of Plant Products.* Vol. 1: *On the Nature and Significance of the Commoner Organic Compounds of Plants.* By Dr. P. Haas and T. G. Hill. Third edition. Pp. xiii+414. (London: Longmans, Green, and Co., 1921.) 16*s.* net.

(2) *Kieselsäure und Silicate.* By H. le Chatelier. Berechtigte Uebersetzung by Dr. H. Finkelstein. Pp. xi+458. (Leipzig: Akademische Verlagsgesellschaft m.b.H.: Gustav Fock, 1920.)

(3) *The Volatile Oils.* By E. Gildemeister and Fr. Hoffmann. Second edition by E. Gildemeister. Authorised translation by Edward Kremers. Second volume. Pp. xx+686. (London: Longmans, Green, and Co., 1920.) 32*s.* net.

(4) *The Fundamental Processes of Dye Chemistry.* By Prof. H. E. Fierz-David. Translated by Dr. F. A. Mason. Pp xiv+240+19 plates. (London: J. and A. Churchill, 1921.) 21*s.* net.

(1) MESSRS. HAAS AND HILL'S "Chemistry of Plant Products" is now in its third edition. As it has been reprinted, the opportunity has been taken to rearrange the subject-matter and to devote more attention to physiological problems. This has caused a considerable enlargement of the work, which will now appear in two volumes. The present volume—the first of the series—deals primarily with the chemistry of the subject and, in the main, consists of the chemical matter of the earlier editions, revised and brought up to date, and to some extent rewritten. It is arranged under ten sections, viz.: Fats, oils, and waxes, and phosphatides; aldehydes; carbohydrates; glucosides; tannins; pigments; nitrogen bases; colloids; proteins; and enzymes. Each section is largely subdivided, so as to make it as comprehensive as possible. There is, of course, no necessary chemical connection between the several sections. It is probably impossible to devise a perfectly rational scheme of classification, as in a well-ordered treatise of chemistry, where the several parts are knit together in more or less logical sequence. The scheme adopted by the authors certainly serves to bring together all the more important facts connected with the chemistry of plants and plant products, and with the aid of an excellent index and an ample bibliography there should be little difficulty in the search for information.

The analytical section is one of the most commendable features of the work. It has been carefully compiled, and the several methods are adequately described. It is perhaps impossible now to make the change, but honour is not given where honour is due by ascribing to Fehling the method of determining certain sugars by the reduction of an alkaline tartrate solution of copper sulphate. The real author of this method was the French chemist Barreswil, and his name should be given to it. The merit of the German chemist consisted in studying the conditions under which the method gave consistent and uniform results, but he added no original feature to the process. In consequence of the great development of the sugar industry in Germany, Fehling's directions were generally followed in that country, and his name came to be associated thereby with the method. Similar instances of misappropriation are not unknown in German chemical literature.

(2) Dr. Finkelstein's translation of le Chatelier's admirable monograph, "La Silice et les Silicates," was made during the winter of 1913–14—that is, within a few months of the appearance of the French work—but its publication has been delayed by the occurrence of the Great War. The delay has, however, enabled the translator to include a certain amount of new matter dealing with refractories, and has thereby added to the value of the treatise. Le Chatelier's work on silicic acid and its industrially important compounds is unquestionably the most learned contribution yet made to the literature of the subject. It is a model of what such a monograph should be—excellently arranged, clear, concise yet adequately full, and scrupulously accurate. The compilation of such a work must have required an enormous amount of research and reading, in addition to an intimate personal acquaintance with the subject based upon long-continued original inquiry. Indeed, this note of originality, obvious on almost every page, is one of the most characteristic features of the book. It is to be seen in the judicious and critical treatment of the subject-matter, even when the author is dealing with other men's work, all of which is

tried and tested in the light of a personal experience well-nigh omniscient so far as regards the material in question.

Dr. Finkelstein has done his work excellently, and his translation reads well. He has managed to convey something of the clarity and polish of style of the original. The book is well illustrated with *clichés* from the French edition, and is admirably printed. It is, however, worthy of a better index.

(3) The printing of the English translation by Dr. Kremers of the second volume of the second edition of the standard work, by Gildemeister and Fr. Hoffmann, on the volatile oils was completed in 1916, but its publication was delayed until last year. The treatise, which is the most authoritative work on the so-called essential oils, is produced under the auspices of the well-known firm of Schimmel and Co., of Miltitz, near Leipzig, who are among the leading manufacturers of these products, and have contributed largely to our knowledge of their chemistry by the systematic investigations which they have caused to be made. In fact, a very considerable amount of the analytical and physical data concerning this particular class of substances emanates from their laboratories.

The number of the essential oils already known, and more or less well investigated, is legion. The volume before us describes the chemical and physical characteristics of upwards of 400, and includes only the oils up to and embracing those of the Zygophyllaceæ and of part of the Rutaceæ of Engler's "Syllabus der Pflanzenfamilien." Another volume will be required to deal with the rest. Many of these substances are obtainable in very small quantity, and have little or no commercial value. Others are important articles of trade and produced in large quantities. Whether they are made in large or in small amounts, their regular investigation is part of the routine work of the Schimmel laboratories, and the results are published periodically in their well-known reports; ultimately they find their way into the successive editions of this treatise. Of course, the book also takes note of other published work. Indeed, its bibliography is an important and valuable feature of the work. Practically everything that is known at the time of compilation or revision on the subject of volatile oils is probably to be found in it.

The book is suitably illustrated with reproductions from photographs and drawings of apparatus and distilling plant, and it is also provided with excellent maps of the areas of production of some of the more important oils. Its bibliography and index are remarkably complete. As a work of reference it leaves little to be desired.

(4) Dr. F. A. Mason has put the colour industry of this country under an obligation to him by his translation of Prof. Fierz-David's well-known work on "The Fundamental Processes of Dye Chemistry." It deals with the general operations—sulphonations, nitrations and reductions, chlorinations, oxidations, condensations, azotisations, and couplings—incidental to the manufacture of synthetic colouring matters, and describes the intermediates employed and the special apparatus needed. These operations should be carried out on a semi-manufacturing scale, and the apparatus involved should be similar in character to that employed in actual practice. The several processes are described in full, and illustrated by drawings and plans, such as an engineer could work from, of the plant to be used.

Valuable features of the book are the notes on works technique and on works management, which are based on an extensive practical experience. It will surprise some people to be told that, as compared with other industries, the value of the entire world production of dyes is very slight, its worth, according to Prof. Fierz-David, being in 1913 20,000,000*l.*—not more than a tenth part of the value of the wool crop, or a fifth of the cotton crop, or a third of the rubber crop. The chance, therefore, that synthetic dyes, made in Germany, can furnish any considerable fraction of the amount demanded by the Allies by way of "reparations" is not so great as is generally supposed. At the same time that is no reason why the manufacture, which is a staple industry in Germany, should not bear its proper share of the penalty which Germany has incurred by her unrighteous acts.

Institution and Behaviour in Fijian Society.

Fijian Society; or, The Sociology and Psychology of the Fijians. By the Rev. W. Deane. Pp. xv+255. (London: Macmillan and Co., Ltd., 1921.) 16*s.* net.

MR. DEANE'S work deals, among other topics, with the child-life, games, religion, ancestor-cult, sacred stones, symbolism, moral character, etiquette, fishing, food-prohibitions, and cannibalism of the Fijians. He does not attempt to give more than a sketch of some aspects of Fijian life, and some value is taken from his work by his habit of quoting other authorities instead of telling his own story. The authoritative work on Fiji has yet to be written,

and ethnologists are eagerly awaiting some such work from the pen of Mr. A. M. Hocart, whose preliminary sketches give promise of so much to come.

The work under notice is, in its way, excellent. In his treatment of psychology the author does not follow the usual practice of accounting for the beliefs and practices of uncivilised folk by means of some extemporised psychological explanation. On the contrary, his work contains some of the soundest social psychology that it has been our good fortune to read for many a day. The author is keenly aware of the interrelationship of social institution and behaviour. For instance, he, along with the Rev. T. Williams, fails to detect any element of wonder in Fijian religion, but finds plenty of fear. He does not, however, claim that this fear has been aroused in the Fijian by his experience of natural phenomena; on the contrary, "the answer is to be found in his history and past social life." The Fijian race has had a warlike past, and the people have been at the mercy of cruel, warlike chiefs. "He knew what invasion meant, and he was a victim to the war-terror by night and day. . . . Fear was 'bred in his bone.' It is not wonderful, therefore, that fear came out in his religious life . . . at the present time, fear is inseparable from the Fijian nature, and . . . this fear is the result of his history and past social environment."

Again, in speaking of the moral character of the Fijian, Mr. Deane says: "Many people are led by erroneous or narrow conceptions of social life in general to forget that the Fijian's past is crystallised in his present social surroundings, and they proceed forthwith to pronounce judgment upon him as if he had had the same history as a European. The diagnoses of such people are, therefore, often unjust, caustic, and unscientific. For they take single threads of his character, and judge therefrom the warp and woof of all." In some capital chapters on the influence of social organisation on behaviour, the author sums up his method of inquiry in terms that reveal his attitude: "So far we have examined the Fijian character as *expressed* in certain religious beliefs, social customs, and ceremonial symbols. We shall now study it more directly as the *outcome* of particular social institutions." He proceeds forthwith to give an analysis of the effects of communism upon human behaviour that should be read by some of our individualists, as well as by the communists, for both will find there something to learn that will not entirely please them. Fijian communism has its good, as well as its bad, side.

It is interesting to note that the great increase of warfare and cannibalism in Fiji was due to the introduction of firearms. Europeans have much to answer for in the matter of stirring up strife in various parts of the earth. "The ancient legends describe a peaceful immigration of a few half-shipwrecked and forlorn people. . . . It is not till long after that any serious war is even hinted at"—a state of things that is apparently typical of the early history of the Pacific.

Altogether a readable and eminently human book, with much reasoning on human behaviour far in advance of that usually found in ethnological literature. W. J. PERRY.

Laboratory Designs.

Laboratories: Their Planning and Fittings. By A. E. Munby. With a historical introduction by Sir Arthur E. Shipley. Pp. xix+220. (London: G. Bell and Sons, Ltd., 1921.) 25*s.* net.

AN up-to-date compendium of experience in all that pertains to laboratory design and fittings is provided by this volume, which is well illustrated by plans and sketches of many of the latest buildings for scientific work in schools and colleges. It is accompanied by a criticism of different types, while useful suggestions will be found for making the best use of laboratories run on the more orthodox system of teaching science.

A perusal of the book will well repay those responsible for the extension of science teaching in our educational establishments, and will help to prevent those costly mistakes which, through insufficient knowledge of what has been done elsewhere, have in the past so often characterised the building of scientific laboratories. The publishers, as well as the author, are to be congratulated on the publication of a really useful book in handy size, well bound, and with excellent letterpress.

The first chapter, "The Scope and Inception of Building Schemes," deals with the factors which affect the ultimate design of the building. It is a suggestive presentation of the subject and a comprehensive analysis of the problems that must be considered before any plans can be set out.

Mr. Munby in no way attempts to define the actual requirements of any particular type of school or course of work. His book is intended rather to assist the designer in obtaining the best and most efficient equipment within the limit prescribed by funds available or methods of teaching. Naturally, this has led him to discuss details and designs for the most advanced courses in various branches of science with all the elabora-

tion of subdivision that is found in laboratories of university rank.

For schools a much simpler scheme of fittings is necessary; it is in connection with schools rather than with colleges that new buildings are likely to be required in the near future, although it is impossible to standardise their requirements. The author rightly points out that a great change is taking place in educational methods, and that natural science is likely in the future to become, at least in its elementary stages, more and more diffused into other school subjects, so that eventually every class-room may require special fittings, while the *rôle* of the laboratory as a thing apart may gradually disappear. Such evolution is well exemplified in the teaching of geography. Hence considerations such as these must materially affect all laboratory arrangements and must not be lost sight of in the development of any scheme embarked upon; provision must always be made for extension or adaptation.

The book is refreshingly free from bias; alternative plans are discussed, advantages and disadvantages pointed out, and it is wisely left to the reader to decide what to adopt, modify, or omit.

It is difficult to find any subject concerning the equipment of laboratories and lecture theatres omitted, no matter how trivial. Every possible fitting seems to be described, and the latest designs referred to, in addition to the many valuable hints as to the general arrangements of rooms, their accessibility, relative position, and organisation. Thus while the book itself is not so much constructive as descriptive, it will enable those upon whom is placed the responsibility of all future buildings for science teaching to have at hand a useful guide and trustworthy adviser.

Chap. 2 concerns the requirements of chemistry, chap. 3 those of physics, and chap. 4 those of biology and geology. In chap. 5 the supply of gas, water, steam, and electricity, the ventilation of fume cupboards and hoods, and the more detailed forms of drains are discussed.

The last chapter contains a good description of science buildings: (1) of recent school designs, (2) of recent designs for advanced work, and (3) of recent foreign designs.

Mr. Munby has ably presented his subject, the mass of detail and information being admirably arranged and indexed. The well-executed plans of the various types of laboratories drawn to scale will enable the reader to compare the merits of the various designs, and the many sectional drawings which illustrate points of special construction add much to the value of the book.

CHAS. E. BROWNE.

The History of Anatomical Illustration.

History and Bibliography of Anatomic Illustration in its Relation to Anatomic Science and the Graphic Arts. By Ludwig Choulant. Translated and edited, with notes and a biography, by Dr. Mortimer Frank. With a biographical sketch of the translator and two additional sections by Dr. F. H. Garrison and Dr. E. C. Streeter. Pp. xxvii+435. (Chicago, Ill.: The University of Chicago Press; London: The Cambridge University Press, 1920.) 10 dollars net.

SCIENTIFIC books have short lives. A textbook that makes an especial appeal is sometimes edited and re-edited, and may last, in a form scarcely recognisable from its first state, for a generation or even for two. On the other hand, works containing new and original contributions are eagerly read for a short time, and their results rapidly absorbed into the pages of their successors. The older work then takes its place on the less accessible shelves of the library, and is sought from time to time only by the conscientious bibliographer. The ecological relationships of living and of dead literature may be compared to that of certain plant masses in which the upper surface alone is living and growth takes place on the hidden mass of dead vegetation.

It is the special and probably unique distinction of Ludwig Choulant (professor of medicine at Dresden, 1823–60) that he was the author of two works of reference that have remained in continuous, unedited, and constant use for man's allotted span. These works are, it is true, limited in range and used by few, but within their own field they stand as yet unrivalled and unchallenged. Choulant was a man without genius, but of wonderful erudition and sound judgment, and with a real gift for the most minute accuracy combined with great power of literary condensation. His "Handbuch der Bücherkunde für die ältere Medicin," first published in 1828, appeared in a new edition in 1842. This second edition is still by far the best and most complete bibliography of ancient medicine, and is an essential reference book in every medical library, and quite indispensable to the medical historian. It may be doubted if there has ever been printed another reference book in any field that exhibits such extreme accuracy. Knowledge has naturally advanced in the century that has passed since it first appeared, and there are, therefore, lacunæ in Choulant's work. But the constant use of the book for many years has never revealed to the present reviewer a single error that its author

could have avoided, nor has he ever been able to hear of the detection of one by other workers.

Choulant's second great work was his "Geschichte und Bibliographie der anatomischen Abbildung" (Leipzig, 1852). This useful reference book has always appealed to a somewhat wider public than his "Handbuch der Bücherkunde." While no less accurate than its fellow, the lacunæ have become more serious with time. Notably, the curious and interesting subject of medieval anatomical illustration, entirely unknown in Choulant's day, has been created in our own time mainly by the labours of Sudhoff. Dr. Mortimer Frank, a learned young ophthalmologist of Chicago, therefore, in preparing a translation of Choulant's work, attempted to bring it up to date and to bridge the gaps. Frank's death at the age of forty-four, before his work reached the press, prevented his task from being quite so thoroughly finished as he himself had designed, but he had time to add a most valuable chapter on the medieval illustrations and to supplement largely Choulant's references. He has thus rendered yeoman service to the study of medical history. The work has been seen through the press by the accomplished historian, Col. F. H. Garrison, of the Surgeon-General's Library, assisted by Dr. E. C. Streeter, and these two writers have added useful chapters on anatomical illustration since Choulant, and on sculpture and painting as modes of anatomical illustration. The book is admirably illustrated and printed, and in its present form entirely replaces the original edition. CHARLES SINGER.

Our Bookshelf.

Some Birds of the Countryside: The Art of Nature. By H. J. Massingham. Pp. 208. (London: T. Fisher Unwin, Ltd., 1921.) 12*s.* 6*d.* net.

ALL lovers of open-air Nature, and especially those of birds, will thank Mr. Massingham for putting together in one handy little volume those charming articles of which some have already been published in the *Spectator, Contemporary Review,* and elsewhere. Throughout the book the reader is by felicitous phrase and by the inborn sympathy of the author with Nature in all her moods transported into the "field"; yes, even when the chapter is entitled "Bird-haunted London." With singular literary skill Mr. Massingham presents his pictures, whether of landscape or of his favourite birds, so vividly that scene, incident, and character live in the reader's mental vision. No writer of our acquaintance has succeeded better in seeing into and interpreting the behaviour of birds, and that without undue anthropomorphism. But the reading of character extends beyond a nice and artistic sympathy with feathered life, for the chapters on "Gilbert White and Selborne" and "Charles Waterton" are masterly appreciations of two diametrically different naturalists. In each we end the chapter feeling that we know the man better than ever before, and understand why the fame of one, but not that of the other, has widely endured. If we may be allowed one critical request, it is to entreat Mr. Massingham not to use the word "intrigue" when "interest" will do just as well—indeed, much better. The latter is English, and the former is, we devoutly trust, a mere passing affectation. The book is, however, a very notable addition to the literature of natural history, and should find a place in every library, large or small.

London Trees. By A. D. Webster. Pp. xii+218+32 plates. (London: The Swarthmore Press, 1920.) 15*s.* net.

LONDONERS owe a debt of gratitude to Mr. Webster for this book. Not until its pages have been read will one in a thousand of the inhabitants of the Metropolis have any conception of the variety of trees that grow within its limits. The ubiquitousness of the plane and its surpassing merit as a London tree are apt to give the impression that there is little else. It is, of course, the fact that many of the more uncommon species are hidden away in private or semi-private grounds. The garden of Fulham Palace, for instance, is classic ground to students of trees, for here in the early years of the eighteenth century grew the finest collection of trees in Britain, planted by Compton, then Bishop of London. Fulham is a place very different from what it was 200 years ago, but even now, Mr. Webster tells us, the grounds there are rich in rare and curious trees, some probably the finest in London.

The book consists of two parts. The first and larger is an alphabetical list of London trees briefly but, for the general reader, sufficiently described, with information as to where they are to be found. The second deals with parks, squares, and other open spaces, both public and private, and mentions the more notable trees to be found in each. There are a few errors; the old but exploded idea that the common elm was introduced by the Romans is revived; the author says *Celtis australis* is well represented in the London area, but we doubt if he could find a single tree; nor will the statement that *Platanus occidentalis* occurs in considerable numbers throughout London find general acceptance.

W. J. B.

The Statesman's Year-Book, 1921. Edited by Sir J. Scott Keltie and Dr. M. Epstein. Fifty-eighth annual publication. Revised after official returns. Pp. xliv+1544. (London: Macmillan and Co., Ltd., 1921.) 20*s.* net.

THE fifty-eighth annual issue of this indispensable year-book is before us, and, as usual, it has been revised up to the eve of going to press. The amount of information is no less noteworthy than

the care with which it is edited and the consequent absence of errors. As in previous editions, the volume consists of three parts dealing respectively with the British Empire, the United States, and other countries. The States of the world, enjoying more or less independent rank, now number sixty-four, counting the British Empire as one. Since the last edition of the book the list has been increased by Esthonia, Georgia, Latvia, and Fiume, while Montenegro has been sunk in Yugo-Slavia, or, to use its unwieldy official name, the Serb, Croat, and Slovene State. Irak, Palestine, and Armenia, as well as some of the amorphous States in process of emerging from the Russian ruin, are still placed under the countries of which formerly they were constituent parts. The information respecting Russia has been furnished from official Soviet sources, but that Government seems unable to provide recent statistics for Siberia. Of the two maps, one shows the Baltic and adjacent States, including the new access of Finland to the Arctic Ocean, and the other shows the Slesvig boundary adjustment. The introductory tables give statistics of the British Empire for 1919–20, the world's production of gold, silver, sugar, etc., the distribution of shipping and naval strength, and other useful information. The covenant of the League of Nations is given in full, and there is a list of the treaties of peace and official publications thereon.

Advanced Lessons in Practical Physiology for Students of Medicine. By Dr. R. Burton-Opitz. Pp. 238. (Philadelphia and London: W. B. Saunders Co., 1920.) 18*s.* net.

No subject in the medical curriculum affords so great a variety in the scope and manner of its presentation as does that of experimental physiology. Probably no two schools are alike in their treatment of this fundamental branch of medical training.

Dr. Burton-Opitz's text-book describes a course which strikes one as being too comprehensive. Omitting physiological chemistry, it takes the student over a range of experimental work beginning with the nerve-muscle preparation of the frog and passing to more advanced experiments, such as cerebral localisation and gastro-enterostomy in the living mammal. The course is adapted to the requirements of Columbia University, and, if faithfully followed by the student, takes him far into the practical details of medicine and surgery; but most teachers in this country are satisfied if they give the student a good grounding in some part of the subject and illustrate the more important animal experiments by demonstration. Our laws, indeed, prevent the student from carrying out much of the experimental work which is possible in America.

The course is divided into fifty lessons, for each of which the author states in his preface three hours should be available. One may be permitted to doubt if the student can digest the amount of material prescribed, and few medical schools are in possession of the staff and equipment necessary. The book contains little theory, and the practical directions are in some instances very brief, but they are intended to be supplemented by lectures and demonstrations. The book is not one that will be much used in this country, but it contains valuable suggestions, and will be a useful addition to the literature of the laboratory.

P. T. HERRING.

Papers Set in the Mechanical Sciences Tripos, 1912, 1913, 1914, 1915, 1919. Pp. iv+57. (Cambridge: At the University Press, 1920.) 4*s.* net.

THE student of engineering is by implication a student of branches of science such as mechanics, thermodynamics, electricity, etc., but he studies these subjects from a point of view differing widely from that of the student of pure science. In view of the vast importance of engineering and other technological practice in modern life, there may be some danger of the claims of science as such being somewhat disregarded, and it is therefore of interest to see in what way representative schools of engineering in this country deal with the pure science that enters into their curricula. We get an insight into this by means of the examination papers that are set for honours students in engineering, and the Cambridge University Press affords us an opportunity of doing so in connection with the Cambridge school of engineering. The papers included in the present publication are on applied mechanics, heat, theory of structures, and electricity. The questions demand a sound knowledge of the physical theory of each subject and of its mathematical development, while at the same time they presuppose a close acquaintance with the practical applications for engineering purposes.

Insanity and Mental Deficiency in Relation to Legal Responsibility: A Study in Psychological Jurisprudence. By Dr. W. G. H. Cook. Pp. xxiv+192. (London: George Routledge and Sons, Ltd.; New York: E. P. Dutton and Co., 1921.) 10*s.* 6*d.* net.

MUCH has been written on the responsibility of insane and feeble-minded persons for criminal offences, but Dr. Cook has broken more novel ground in bringing together all available evidence on the difficult question of civil responsibility, a subject which has been rarely dealt with as a whole. In doing so he makes a survey of more than two hundred leading cases and of the laws of many foreign countries. The results thus summarised may, as Sir John Macdonnell, late Senior Master of the High Court of Justice, states in a foreword, "prepare the way for a re-statement of our law in accordance with the teaching of modern psychology." It would be beyond the scope of NATURE critically to review this work, but we may agree with the words from the foreword already quoted, that it will "educate professional opinion, and help to reconcile the lawyer, the physician, and the psychologist."

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Scientific Publication.

DR. BRIERLEY (NATURE, September 8, p. 41) makes several incontrovertible statements and some suggestions that one is less willing to accept. Possibly the views of one who has been an editor off and on for forty years, as well as writer, publisher, and researcher, may assist Dr. Brierley and other struggling colleagues.

It is, as Dr. Brierley says, only the worker going over the same ground who needs to read the details, and I agree that he needs more numerous and more accurate details than he generally gets; for other readers a good summary should be provided. It is also true that those "other readers" are the more numerous, and yet they vary in their requirements so that no single summary is likely to suit them all; each may wish to refer to the full text for the elucidation of some point in which he is interested or ill-informed. It would therefore be unsatisfactory to confine papers to summaries, or even to what one may call "large type matter." But, apart from this, even in abstruse subjects the number of original workers is surely greater than Dr. Brierley allows for. There may not be many in one country, but they are dispersed throughout the world. The Japanese and the American and the New Zealander cannot come to London every time they wish to refer to a manuscript. The proposal to make a few copies by some cheap process is, I suspect, illusory. At the moment compositors and pressmen may be sucking our blood, but normally linotype printing is as cheap a process as any. I therefore advocate printing papers in full, with all necessary detail and adequate illustration.

This, Dr. Brierley will reply, leaves us worse off than before. What, then, are the remedies? Dr. Brierley tells us that a lot of papers are only to mark time or make a show. He is an editor. Does he accept such papers? The remedy is in his own hands. Or has he lost his blue pencil? But even the better-class papers can stand some editing and condensation. A large number of scientific workers are far too lengthy (I do not mean too long); they use six words where one will do, and, like the bad speaker, take up space with telling us how brief they propose to be and what a heap of good cargo they have been compelled to jettison. These faults will increase as linguistic training, especially in Latin, decreases in our schools.

Many of our scientific journals, especially those started in years of prosperity, are needlessly sumptuous. No journal need cut out matter so long as it allows a quarter of a page or more to the author's title and titles. The illustrations in these journals are often on an absurdly large scale, and there is too much printer's "fat." Footnotes are generally a sign of undigested matter and chaotic thought. They add to the expense, and should be suppressed (this is a hint to Dr. Brierley as editor). Sensible and succinct methods of referring to literature are being adopted and enforced by modern editors, but there is room for improvement. On this and similar matters there are the Reports of the British Association Committee on Zoological Bibliography and Publication, which I shall be glad to send to inquirers.

Some authors have a habit of writing a separate paper on each aspect of a single subject; and three such papers may appear in one number of a journal, each with its quarter-page heading and half-page blank at the end. This habit is much in evidence in the modern journals to which I have referred. There are other authors who write slight variants of the same article for several periodicals. Since they are not paid for their trouble they have no excuse for thus inflicting themselves on a weary public. Suppress them, Mr. Editor! The preliminary notice is frequently a form of this self-advertisement.

We must look at this question as men of business. Does the world want our stuff or does it not? There is a public undoubtedly, though not a very large one. If you give it good value it will pay the price. It is the editor's duty to increase the value of his wares and to cut down the unnecessary costs. His publisher must advertise with the right people and get the right people to advertise with him. If everyone concerned does his duty, I believe a scientific journal, even the purest, can be made to pay its expenses. Heroic remedies are not wanted. F. A. BATHER.

Natural History Museum, South Kensington, S.W.7, September 12.

DR. BRIERLEY'S communication on this subject in NATURE of September 8 (p. 41) is well worth reading again, and my sole object in writing this letter is to direct attention to it, for it appears to me that Dr. Brierley indicates how the problem may be attacked upon sound lines. The method he suggests is "to make a radical change in the format of our scientific journals, with or without an alteration in the existing structural relations of the learned societies." Any "lumping together" of the publications of our scientific societies would undoubtedly meet with much opposition; sentiment, vested interests, and natural conservatism stand in the way. The proposal that only well-digested summaries of papers should be published would certainly lead to saving in money and time, with little countervailing loss.

Dr. Brierley has stressed the saving in money, but the saving in human energy and time is of equal, if not greater, importance. No scientific worker can or dare limit his reading to the confines of his special subject, and "that inundated feeling" is fast becoming a prevalent complaint.

In a new world there will be established for each branch of science in each country a single publication in which all original work will appear; it will be administered by the societies and institutions devoted to that branch of learning, and all progressive work will be entitled to a place in it in the form of a full summary. Subordinate branches of the same subject will be accommodated in separate series as they grow in importance. The monthly, quarterly, or annual indexes of the publication will provide a complete current guide to the subject, and the worker will know exactly where to go for his information. A good national and international sale will be assured; and as all the volumes will be of the same size, there will be a considerable saving in space, material, and temper.

Meanwhile, the innumerable journals that live by advertisements, discussion, and abstracts will continue to fulfil their function and will survive according to their merits; the scientific worker will take in those that are most useful. But for original papers he will turn only to the British publications for British results or to the corresponding French ones for those of France, and so on. In January each year he will be in possession of part 1 for that year, and by December 31 he will have the annual volume complete with indexes, just as in any well-managed journal of to-day.

This vision is not new, and, human nature being what it is, a vision it is likely to remain. Still, if science is "organised common sense," something may be done by applying it to the machinery of publication. Dr. Brierley has made a beginning by taking a square look at the subject. J. A. H.

Jermyn Street, London, S.W., September 19.

Is Bisexuality in Animals a Function of Motion?

It was long ago pointed out by Claus that hermaphroditism in animals finds its most frequent expression in fixed and sluggish animals, and in certain parasites. A large amount of work on sex-phenomena has been done since Claus's time, and his generalisation has been confirmed. There is thus no doubt of the fact that there is a close correlation between an inactive life and hermaphroditism, so close indeed that the present writer is ready to cast suspicion on the supposed bisexuality of any sedentary animal. It is seen therefore that absence of motion is in some way directly or indirectly associated with an hermaphrodite expression of sex.

After Claus a number of writers suggested that fixed or sluggish animals or parasites would accumulate an excess of nutritive products, a condition which was considered sufficient in itself to account somehow for hermaphroditism. This point of view was accepted and developed by Geddes and Thompson, who arrived at the conclusion, in their work on "Evolution and Sex," that "hermaphroditism is primitive and that the unisexual state is a subsequent differentiation: the present (*existing*)[1] cases of normal hermaphroditism (*therefore*) imply either persistence or reversion." More recent workers appear to have neglected the wider aspects of the problem of sex, and to have concentrated on the question of the *mechanism* of sex-determination. Recent discoveries of hermaphroditism, and particularly some cases studied by the writer, have directed attention to a speculation which indeed follows naturally from Claus's observations, namely, *is hermaphroditism a direct physical consequence of a fixed or sluggish life, and conversely, is bisexuality in a species a direct physical consequence of a freely moving habit of life?*

This view has been examined in a preliminary way and has been tested in some of the present writer's recent researches with results which are meagre, but promise more success by a method which involves following closely the life-history of *individuals* of a species. It is to be expected, moreover, that with all the ups and downs in the progress of evolution there will exist an infinite variety of circumstances to obscure such an underlying principle as that suggested above, even should the principle obtain in nature. A phylogenetic explanation of hermaphroditism is unsatisfactory in that it is inherently inconclusive, and in that there is no method of testing it, whereas the speculation advanced here can be tested, and, if found wanting, can be rejected.

In a survey of the sex-phenomena in the animal kingdom it is found, generally speaking, that forms which are slow-moving, sedentary, or of fixed parasitic habit are hermaphrodite—*i.e.* an *individual* will produce eggs and sperm either simultaneously or separately in the course of its life-history—and that animals which are active during life are bisexual, whilst animals which fall into an arbitrary category of sluggish or slow-moving forms, for example Lamellibranch Molluscs, exhibit a wide range of sex-phenomena, from apparent bisexuality to definite simultaneous hermaphroditism. This is not the place to go into full technical details, but it may be mentioned that in the category of fixed or sedentary or sluggish animals (excluding Protozoa) which are hermaphrodite may be entered: Sponges, so far as sex is known in the group, sedentary Cœlenterates (but apparently not all), practically all the members of the following groups—Platyhelminthes (the flat-worm group), Leeches, Oligochæta, Polyzoa, Ascidians, euthyneurous and pteropodous Molluscs, practically all fixed Arthropods, *i.e.* Cirripedia—and various sedentary forms in other groups. Amongst animals which are free-living, active, and bisexual are most Arthropods, all cephalopodous and most streptoneurous Molluscs, and all vertebrates except a few sluggish or parasitic forms. In the intermediate category of groups which are composed mainly of slow-moving forms may be placed Lamellibranch Molluscs, Amphineura, Echinoderms, Polychætes, and Nemertine worms. In all these latter groups hermaphroditism occurs to some extent,[2] and indeed Mortensen[3] has shown recently that a very large number of Ophiuroids are hermaphrodite. Now, in view of recent work on hermaphroditism there is legitimate reason to doubt the supposed bisexuality in a very large number of forms belonging to the groups mentioned here, as may be seen from a review of the sex-phenomena in the oyster and the common limpet. In the oyster (*O. edulis*) we now know that some forms change from males into females and back again into the male condition. In this species, therefore, looked at as a whole, males change into females and females into males. In the limpet (*Patella vulgata*) it would appear that some males change into females, but that individuals very rarely show signs of sex-change owing to a distinct break between the male-functioning stage and the female-functioning stage. *It is therefore possible that in some supposed bisexual species males may change into females and females change into males,* since a parallel series of changes is known to occur in the oyster[4] (*O. edulis*). In such cases the actual sex-conditions in the species could only be found out by following the life-history of individual animals.

If it be supposed that hermaphroditism is a direct physical result of a sedentary life, and bisexuality a direct physical result of an active life, it would appear that there should be some fundamental difference in the physical condition of the general body or in particular organs—*e.g.* the gonad—in these two classes of animals. This deduction should therefore yield a method of testing the speculation. I do not know of any such fundamental difference in physical condition between sedentary and active forms, but the known electrical changes which occur during the activation of muscular and nervous tissues, together with the results of recent studies on electrical characters of tissue elements, lead one to hope that if physical differences of this kind do occur they may be found in the near future. A fundamental difference in physical condition between sedentary and active animals, correlated with different sexual conditions, is probably the touchstone of this speculation, and offers a definite problem for bio-physicists. Contemplation of success in the discovery of such a fundamental difference arouses visions of the determination of sexual characters of species by some sort of physical constant, and a faint

[1] The words in italics have been inserted by the present writer.

[2] I have found that *Lineus lacteus*—a sluggish Nemertine living in gravel at half-tide level—is definitely hermaphrodite; both eggs and sperm are mature in a single individual at the same time.

[3] Th. Mortensen, "On Hermaphroditism in Viviparous Ophiuroids," *Acta Zoologica*, pp. 1–18, 1920. (Stockholm.)

[4] It must be pointed out that we have as yet no clear proof that *all* male oysters or *all* male common limpets change into females; and the present writer's work has shown that sex-change in the slipper-limpet from male to female may be almost indefinitely delayed according to circumstances (Proc. Roy. Soc., B, vol. 81, 1909, pp. 468–84, and unpublished work).

discernment of a possible method of controlling sex.

It is interesting to note that pursuit of this speculation leads one to a view of the paramount importance of the individual as a whole in determining its characters, and in this respect recalls Darwin's hypothesis of pangenesis. It may be pointed out, moreover, that quite apart from theoretical questions the conditions which determine whether an animal is to be hermaphrodite or bisexual must be considered before any reasonable hope can be entertained of understanding the processes underlying sexual differentiation in a bisexual species. Indeed, some inkling of the need for sex might be obtained from an understanding of the conditions resulting in hermaphroditism, and an explanation of sex on purely physical lines would be captivating from the point of view of the student of nature as a whole. The old idea that an individual is female because its metabolism is mainly anabolic, or male because mainly katabolic, is unsatisfactory, and it has already been pointed out that it is just as likely that an individual is anabolic because of its femaleness, or katabolic because of its maleness.

In reviewing the incidence of hermaphroditism and bisexuality throughout the animal kingdom (again excluding Protozoa) one cannot but be impressed by the independence shown by the organism, which would appear to be able to order its sexual manifestations in a manner entirely independent of phylogenetic considerations, and suggests such a ready response to conditions of life as is perhaps not generally conceived.

The practical points arising out of these speculations may be summarised as follows: Is there a fundamental physical difference between sedentary and active organisms in the whole body or in parts, and if so, is this difference correlated in any way with particular sexual manifestations? To what degree is our present knowledge of the sexual conditions in slow-moving or fixed animals reliable? On the basis of the speculations advanced here any animals which are sedentary, fixed, or slow-moving may be suspected of hermaphroditism in some form.

No wholly satisfactory explanations have been advanced for either hermaphroditism, bisexuality, or indeed sex itself. Sex is universally expressed amongst the higher living organisms at least, so that one is tempted to ask: Is sex merely a property of living matter and hermaphroditism that modification of the property resultant upon the absence of motion in the living organism, and bisexuality that modification dependent upon free motion? For there appear to be sufficient grounds for rejecting the idea that animals are sedentary because they are hermaphrodite.

J. H. ORTON.

The Laboratory, Plymouth, September 19.

The Separation of Mercury into Isotopes.

EARLY in 1920 Harkins and Broeker reported a separation of chlorine into isotopes, which amounted at that time to an increase in density equal to 1550 parts per million. About six months later Brønsted and von Hevesy reported a separation of mercury, which was, however, only about one-thirtieth as great, or 50 parts per million. On account of the slightness of the density change reported for mercury, the evidence that it had been separated did not appear to be conclusive, so it seemed worth while to attempt a confirmation by the same method—that is, a vaporisation at low pressures. As a result of 4 cuts of 2 on the heavy fraction or residue the density has been increased by 69 parts per million, and by the same number of cuts on the light fraction it has been decreased 62 parts, or the total density change obtained is 133 parts per million, or 0·027 units of atomic weight.

The mercury was purified by electrolysis, by five fractional distillations at low pressure in a current of pure air, and by one fractional distillation in a high vacuum.

The present evidence that an actual separation of isotopes has been obtained with mercury rests largely in the quantitative agreement between the results of Brønsted and von Hevesy and ourselves with respect to the extent of the separation obtained by a definite cut, which will be termed the *efficiency* of the process. If the efficiency of our ideal apparatus, in which solid carbon dioxide and ether were used for cooling, is rated as 100 per cent., then the efficiency attained by the previous investigators is 75 per cent., while our less ideal apparatus gave 93 per cent. when operated slowly and as low as 80 per cent. when operated rapidly.

We have obtained evidence which seems to indicate that a slight separation of the isotopes of mercury has been secured by a very slow distillation at very low pressures, though a more rapid distillation gave no detectable difference in density.

The relative changes produced in the *atomic* weights of different elements by a definite cut may be termed the separation coefficients. These have the values listed below as determined by calculation, the coefficients for chlorine compounds representing the change in the atomic weight of chlorine. The calculated coefficients are:—Neon, 0·00843; magnesium, 0·00868; lithium, 0·00450; nickel, 0·00758; hydrogen chloride, 0·00950; methyl chloride, 0·00690; chlorine, 0·00494; methylene chloride, 0·00413; chloroform, 0·00295; carbon tetrachloride, 0·00229; and hydrogen bromide, 0·00614. Thus the atomic weight changes most rapidly when chlorine is used in the form of hydrogen chloride. The experimentally determined coefficient for mercury is 0·00570, which is not specially large.

The rate of separation of two isotopes is very nearly proportional to the square of the difference of their atomic weight (or molecular weight when a compound is used), to the product of the mol fractions of the two isotopes, to the logarithm of the cut, and inversely proportional to the atomic (or molecular) weight. This statement and the above coefficients apply as well to molecular diffusion at low pressures as to vaporisation at low pressures.

It is of interest to note that many molecular substances must appear in many isotopic forms. Thus if there are two isotopes of chlorine and three of magnesium there are nine isotopic forms of $MgCl_2$, and seven forms of C_6Cl_6, while if there are six isotopes of mercury there are sixty-three isotopic forms of Hg_2Cl_2, which occurs in the form of a vapour. Five of the seven isotopic hexachlorobenzenes also occur in several isomeric forms. Isotopes may be able to produce stereoisomerism with respect to infra-red rays.

WILLIAM D. HARKINS.
R. S. MULLIKEN.

University of Chicago, August 31.

Relation of the Hydrogen-ion Concentration of the Soil to Plant Distribution.

THIS subject has recently assumed prominence among ecologists and soil chemists, and Dr. Atkins's interesting letter, with its valuable data, published in NATURE for September 15 (p. 80), directs general attention to it and to the need and scope for further work thereon.

It seems very desirable to bear in mind that there are strong indications that the relation between the

hydrogen-ion concentration and the flora of a soil is mediate, and not immediate. Hoagland has shown that barley will withstand a very much greater hydrogen-ion concentration in a water-culture solution than it will tolerate in a soil. Also, it is known that plants which are usually very susceptible to acidity will thrive in certain soils of California and Sweden the *p*H of which is between 4 and 5, and that those plants growing in those soils show no response to liming. The inference is that the effect of the hydrogen-ion concentration *of the soil* on plants is indirect, and that there is some ulterior factor the fluctuations of which are commonly, but not invariably, accompanied by fluctuations of hydrogen-ion concentration. In the search for that ulterior factor it has been fairly well demonstrated that in many soils certain polyvalent ions (chiefly aluminium ions) are the primary cause of the effect of acid soils upon plants. It is clear that in mineral soils variations in the aluminium-ion concentration will roughly correspond with variations in the hydrogen-ion concentration.

I am not aware that any explanation has been advanced to account for the fact stated above, that in some soils a high hydrogen-ion concentration is not accompanied by that effect on plants which usually accompanies such hydrogen-ion concentration in soils. The fact alone seems to preclude any possibility of the effect in question being directly and immediately due to the hydrogen-ion, and if it is due to the aluminium-ion it remains to be shown that a high hydrogen-ion concentration in a soil may sometimes exist without a corresponding concentration of aluminium-ion. That may occur in the presence of much organic matter, for it is well known that in the presence of almost any hydroxy-organic compound aluminium (and ferric) ions are "masked." Presumably the aluminium, in such circumstances, becomes part of a complex electro-negative ion—certainly it does not behave chemically like the aluminium-ion.

So far as I can ascertain, the Californian and Swedish soils that have a high hydrogen-ion concentration which is without detriment to plant growth are all peat soils, and it seems likely that the absence of "sourness" in the presence of acidity may be due to the effect of certain organic compounds upon aluminium salts. This possibility is being investigated here and it seems to offer a solution of some other soil-plant problems.

The accumulation of such valuable data as that given by Dr. Atkins is, as that writer says, necessarily slow. Even at the risk of making it slower it seems important to remember that the ultimate interpretation of such data is likely to be possible only in the light of detailed knowledge of the soils concerned. The relation of hydrogen-ion concentration to plant growth is a relatively simple problem: the relation of the hydrogen-ion concentration *of the soil* to plant growth is a very complex problem.

NORMAN M. COMBER.
Department of Agriculture, The University, Leeds,
September 17.

The "Proletarisation of Science" in Russia.

LIKE the majority of people in this country, where the news we receive about what is going on in Russia is often misleading, I know little about the working of the "proletarisation of science" on which Dr. Boris Sokoloff writes in NATURE of September 1. But the omission by Dr. Sokoloff of any account of the constructive elements of this "proletarisation," with one of which I have recently become acquainted, suggests that he is more concerned with spreading propaganda against "Bolshevism" than with giving an outline of all the features, good and bad, of the attitude of Bolshevism to science.

The particular constructive element to which I refer is the effort of the Soviet Government to bring the fundamental conclusions of scientific thought within the reach of the "proletariat" with the deliberate purpose of shaping the mental outlook of the masses, and especially of the rising generation, in such a way that the standard of values in everyday affairs will be based on a naturalistic interpretation of man's environment and of his relations to it. In pursuance of this end the Soviet Government has already issued a whole series of elementary text-books ("Estestvenno-Nauchnaya Biblioteka"), which aim at explaining the scientific position in terms intelligible to the "proletariat," many of whom have learned to read only since the advent of Bolshevism. They are written by scientific men who have remained in Russia, and who, like most of our own men of science during the war, have temporarily suspended their "free" researches in order to take part in work directed to particular ends considered by the State to be more immediately important under the existing emergency. The series includes such subjects as "How Man Arose," "Human and Animal Evolution," "The Origin of the World," "What Chemistry and Physics Teach Us," "Popular Astronomy," "Brain and Spirit," "Outline of the History of Geological Knowledge" (by Prof. A. P. Pavlov), etc., as well as translations of Geikie's "Physical Geography" and other books.

It would be difficult to imagine the present Government of any of the nations of Western or Central Europe, evincing such a faith in science, as able to bring about the "change of heart" on which alone a new society could be founded, that in the midst of all the horrors of blockade, invasion, and civil war its publishing department would issue broadcast to the "proletariat" a whole library of introductions to scientific thought.

H. LYSTER JAMESON.

Bees and Scarlet-runner Beans.

I HAVE been much interested by Mr. Harford J. Lowe's letters upon this subject in NATURE (August 12, 1920, and July 28 and August 11, 1921), and have been led by them to observe the runner beans in my own garden, which lies fourteen miles to the north-west of London. My experience differs somewhat from Mr. Lowe's, and may be worth recording. Although I searched diligently through the whole summer, I did not, until September 1, find a single open flower that had not been pierced through the base of the corolla by the humble-bees in the way described. During the drought there was never more than an occasional pod, although the plants were strong and the flowers very abundant. But after the rain which fell on August 17 pods at once began to form freely, and there has been a plentiful and continuous crop ever since. I then examined the withered petals clinging to the young pods, and found that these also had always been pierced at the base.

It is clear, therefore, that the evil practice of the humble-bees does not necessarily lead to barrenness, and may possibly not do any harm at all. The drought is indicated as the direct or indirect cause of the initial failure of the crop. Now, in mid-September, the humble-bees do not come out so early, and in the morning I have found a very small proportion of uninjured flowers which were being visited by the honey-bees through the legitimate entrance.

H. B. HEYWOOD.

The Norman Lockyer Observatory.

By PROF. H. H. TURNER, F.R.S.

CAN an observatory be run on the co-operative principle or as a joint stock company? The idea is a novel one, but it is the function of science to make experiments, and the tentative beginnings of the experiments in this directon are not unpromising.

The reasons for establishing an observatory at Salcombe Regis in the first instance need not, perhaps, at the present moment be recalled. Suffice it to recognise that the observatory exists, is well equipped with instruments and an excellent climate, and has an efficient, though small, working staff; it has, moreover, the advantage of association with a great name, the brightness of which promises to shine out more clearly as the dust of

FIG. 1.—Norman Lockyer Observatory. The Frank McClean dome on the right and the Kensington dome on the left. View looking south-west.

controversy is swept away by the fresh breezes of modern research.

Years before anyone else, Norman Lockyer suggested that there was an ascending and descending scale for stellar temperatures, which is now the orthodox modern view. It is true that the modern recognition of this characteristic of stellar evolution is based on grounds differing from those chosen by Lockyer for the erection of his theory, and the difference might have been vital. We owe Prof. Eddington a debt of gratitude for stating fearlessly that the difference is small compared with the sameness, and it is matter for congratulation that this recognition was forthcoming, if not actually in the presence of Sir Norman Lockyer, at any rate in the presence of his family, who were able to carry the account of it to him almost immediately. None of those who were present at the little gathering at Sidmouth which followed the meeting of the British Association at Bournemouth in 1919 are likely to forget it.

In the two years which have elapsed since that meeting events have moved quickly, at any rate in some ways. First, there has been at least one other visit of importance—Mr. and Mrs. Evershed were able to spend sufficient time at Salcombe Regis to report very favourably as to its observing climate. Their experience in judging climate is well known; we need only recall the expedition to Nelson (New Zealand) in connection with the offer of Mr. Cawthron to found a solar observatory, and the several expeditions to Kashmir with their varying fortunes. From these adventures has emerged the conviction that a moist climate is preferable to a dry—a conviction which, although at variance with some conclusions adopted in recent years, returns to the views of Sir William Herschel, who has recorded the magnificence of a night for observing when the dew had been so heavy that those who slept while he was at work could not believe on waking that there had not been heavy rain. The satisfaction of Mr. and Mrs. Evershed with Salcombe Regis is, therefore, in keeping with their previous conclusions; it seems even possible that when they leave Kodaikanal and return to England presently (an event which we shall regard with mixed feelings) they may even select Salcombe Regis for their next place of work; but that, of course, is still to be decided.

Another visit to England, though not actually to the observatory itself, has been also attended with happy results. Mr. W. S. Adams, of Mount Wilson, was in England in 1919 on his way to and from the Brussels Conference; it was natural to consult him about the work of the Norman Lockyer Observatory, which at that time was

limited to the taking of stellar spectra and classifying them on Lockyer's principle of classification. Adams suggested at once that it might be possible to measure the spectra in the manner he has developed for the determination of the absolute magnitude of a star, from which its distance might be deduced. This suggestion has been taken up at the observatory with very creditable success. It is obvious that to take up new work of this delicate kind involves much preliminary experiment; the method depends essentially on estimating the relative intensities of pairs of lines in the same spectrum, and the uncertainties attending estimates of intensity are well known; but these difficulties have been courageously faced. We may quote a sentence from the last report:—"A wedge has been designed and constructed for this purpose, and a preliminary series of measures made to test its suitability. This method of measuring relative intensities of the lines appears to be quite satisfactory, and two reports on the work which have been sent to the Research Committee have been commented upon very favourably."

Should this early promise be maintained, the observatory will have initiated a line of work new to England, and, indeed, so far as we know, new everywhere excepting at Mount Wilson. Meantime the former work of classification will not be neglected, and will possibly be extended by adding accurate determinations of the Harvard classification for comparison with those of the Lockyer classification. Such a systematic comparison must be of great value for arriving at a final standard system, whatever that may be.

It is a special pleasure to reflect that this work accords so closely with the ideas of the late Dr. Frank McClean, F.R.S., whose telescope has been presented to the observatory by his sons. Dr. McClean's own work in classification of spectra, especially for stars in the southern hemisphere, and his measurement of some of them by which he discovered for the first time the existence of oxygen in the stars, are matter of history; and it may safely be asserted that if he were alive to-day to make a choice he could scarcely have found work for his old telescope in closer conformity with that which it executed in his own capable hands.

His sons have throughout shown a filial interest in the observatory, and their share in the endowment of it has been very generous; but there are natural limits to private munificence, or at any rate to the purses of one or two individuals, and if the observatory is to prosper as it deserves, further help, which is urgently needed, must be sought for elsewhere; and this brings us back to the question with which we started—viz. Can an observatory, and especially can this particular observatory, be run as a joint enterprise? The idea was put forward first in June, 1914, but the war brought inevitable delays, so that only recently has it been possible to face the situation definitely.

FIG. 2.—Norman Lockyer Observatory. Offices and terrace, looking north.

The quickest way to make clear the nature of the suggested new departure is to quote the following sentence from the little handbook compiled by Major Lockyer (6*d.*) giving an excellent account of the observatory: "Anyone can further the interests of the observatory by joining the corporation, either by subscribing a guinea a year, and thus becoming an annual member, or by paying 10*l.* and becoming a life member." Communications should be addressed to the honorary secretary, Capt. W. N. McClean, 1 Onslow Gardens, London, S.W.7. There are, of course,

the executive council of thirteen names, and a research committee of four names (the Astronomer Royal and the professors of astronomy at Cambridge, South Kensington, and Oxford) prepared to give advice on scientific matters; there is also a most distinguished list of eight foreign members; but it is the hope and intention to make the direction as democratic as possible, if members of the corporation are ready to manifest an interest in the affairs of the observatory.

What are the prospects of such a novel method? A little reflection suggests at once a few directions in which advances may be made, and we may trust the future in this as in other scientific work to open up new avenues. We may begin with the well-known and widespread desire of many people to have opportunities of using a fairly large telescope; they cannot afford to possess one, and perhaps are not prepared, even if they could afford the instrument, to face permanent work with it; but they would welcome the possibility of work for a time with an instrument of some size which they need not purchase. Existing observatories can scarcely meet this desire; they have their own work to do, and their staffs are not generally more than sufficient to do it. Recently the Astronomer Royal has generously placed a large telescope at the disposal of some well-known amateurs on a special occasion, and it may be possible to extend this courtesy further; but it is an entirely new departure, and may find natural limits. At the Norman Lockyer Observatory there are as yet no limits to the possibilities, except the smallness of the staff, and should there prove to be a real demand for opportunities of work for a few months the arrangements are as yet fluid enough to meet the demand. Of course, the expenses must be met, just as must those of any other scientific society. At present the number of members of the corporation is limited by the constitution to three hundred, and it is obvious that the normal subscriptions, even when this limit is reached, which is not so yet, would be far from sufficient, without generous donations, for the upkeep of the observatory. If, however, the corporation could be extended to the dimensions of a scientific society, the question of expense might find an answer. It may be confidently asserted that those who made the experiment of working at the observatory for a week, or a month, or a year would enjoy the experience; Sidmouth itself is a well-known resort, and the observatory has a splendid outlook.

It is by no means necessary that the work selected by a visitor should be confined to night work. There are spacious offices and computing rooms, in which a piece of photographic measurement, or of computational work, or even literary work, could be carried on in pleasant and healthy surroundings.

There may be many who are desirous of the kind of holiday which will take them into new surroundings and yet can be combined with work which they could scarcely do in an hotel or in lodgings, or they possibly have some instrumental idea to be tested for which their own home scarcely provides a site. One of the conspicuous advantages of the Norman Lockyer Observatory is its splendid expanse of 7 acres, where even a large experiment could be conducted without interference with existing plant. The horizon is quite clear, the library and other buildings having been placed under the brow of the hill so as not to obstruct it.

The sight of this wonderful amount of space is enough to raise envious thoughts in the breasts of those who have to struggle with lack of room, and is apt to start various trains of thought. What is to happen to all our astronomical libraries, already full to overflowing, in twenty years' time? Shall we not be driven to the selection for preservation of a few representative lines only, seeking references elsewhere when they fall outside these lines?

The idea of a comprehensive central reference library thus suggests itself. At present it exists, indeed, at the rooms of the Royal Astronomical Society; but space in London is limited and valuable, and the time may come when it must be sought elsewhere. The broad acres at Salcombe Regis may find a use of this kind. A case nearly analogous is that of astronomical photographs. There is in England no great reference store such as that at Harvard, where questions of astronomical history may be settled. Those of us who have profited by this great resource of Harvard have at times felt a little ashamed to draw on Transatlantic courtesy without doing something in return. The characteristic of any collection of the kind is growth—fairly rapid growth—and here again the broad acres have their attractions.

But these are visions of the future. Returning to the more practical present, we may remark that those who use the observatory should certainly include research students from the universities or elsewhere, especially those who may wish to become acquainted with the particular work being done at the observatory, as above outlined. The goodwill of the staff has already been manifested to one such student, and they are preparing to receive another. Here again there is an absence of prescribed conditions which can scarcely attach to universities themselves. They must in self-defence make conditions of joining the university, or some equivalent, which may not be convenient to the intending researcher. No doubt the Norman Lockyer Observatory will expect some *quid pro quo* if it is to continue to exist, but the conditions are as yet to be fashioned. It is for those who join the corporation, if they will, to determine, for instance, whether membership shall carry with it the possibility of recommending a friend to the privileges of the observatory, and on what terms; indeed, the possibilities are so wide that even to give representative instances may have the appearance of narrowing them. They might even include (though here we are venturing on rather dangerous ground) provision for the mere

sightseer—the man or woman who "has never seen the moon through a telescope." This is scarcely possible with the present small staff, but if ways and means could be found it would be well worth while for other observatories to be among the subscribers to the corporation, if they could thereby transfer a part or the whole of their embarrassments from sightseers. It is worth remarking that the situation of the Norman Lockyer Observatory would probably attract this type of visitor, who naturally expects to climb a tower or a hill, and would not be disappointed. But we should prefer to lay stress on the more serious uses of the observatory.

The Oxford Expedition to Spitsbergen, 1921.

ORNITHOLOGICAL OBSERVATIONS.

By the REV. F. C. R. JOURDAIN (Leader of the Expedition).

ALTHOUGH the collections made by members of the expedition have not yet been worked out, it is now possible to form some idea of the extent to which our knowledge of the Spitsbergen group has been increased by the Oxford Expedition of 1921. Owing to difficulties caused by industrial unrest both in England and Norway, the original plans had to be considerably modified, and it was agreed to carry out a biological survey of the southern half of Bear Island, with special reference to the ornithology, before proceeding to the west coast of Spitsbergen.

Practically no work of any importance in this field has ever before been undertaken by Englishmen, and no collections from here exist in any British museum. The only important works on the ornithology of this most interesting, but somewhat inaccessible, spot are Swenander's "Beiträge zur Fauna der Bären-Insel," published in the K. Svenska Vet-Akad. Handl., Bd. xxvi. (1900), and some passages in the great work of Koenig, "Avifauna Spitzbergensis" (1911). Swenander visited Bear Island in 1899, and recorded twenty-two species, while Koenig increased the number to thirty-six, but some of these rest on rather dubious evidence.

The northern half of Bear Island is flat, and covered with innumerable lagoons, but the southern half is hilly, and the coast line consists almost entirely of bold cliffs, which are the resort of millions of sea birds. It is this portion of the island which was investigated by the expedition. Two hitherto unrecorded breeding species were recognised in 1921, and both cases are of great interest as filling up gaps in the distribution of the species concerned. Additions were also made to the list of casual visitors, but more important was the acquisition of a series of nearly eighty skins of breeding species and more than 300 eggs from the island. Equally valuable are the biological notes on the share of the sexes in incubation, the courtship and breeding habits, of which very little has been recorded in the case of these Arctic species.

Actual work on the Spitsbergen group did not begin until June 25. Here, again, it must be remembered that the latest English work on the ornithology of Spitsbergen is Mr. Trevor Battye's paper in the *Ibis*, 1897, pp. 574–600. No series of skins from here with any pretension to completeness exists in any British museum. The eggs of the Barnacle Goose have previously been taken by only one expedition, viz. that of Prof. Koenig in 1907 and 1908, and the twelve eggs then obtained were the only wild-laid eggs known to science till the present season, when twenty-two eggs were obtained by the Oxford Expedition.

[*Photo, Seton Gordon.*

FIG. 1.—Red-throated diver on nest.

Mr. J. S. Huxley's researches on the courtship of the Red-throated Diver (*Colymbus stellatus*) (Fig. 1) and the Grey Phalarope (*Phalaropus fulicarius*) are referred to later, and need not be touched upon here.

In Mr. Trevor Battye's paper only twenty-nine species were recorded from all sources. Since then the total has been raised to fifty-three, and

of these no fewer than thirty are now known with certainty to breed locally. Probably one of the most valuable results of the expedition will prove to be the additional light thrown on the breeding ranges of many northern forms. For example, in Koenig's great work only about seven definite occurrences of the Turnstone (*Arenaria interpres*) are recorded, of which two are also mentioned by Trevor Battye. Yet in 1921 not only were specimens actually obtained from two localities in Ice Fjord, but also about nineteen pairs were met with breeding in one restricted district on the north coast, and adults, young in down, and eggs were collected. This clears up the mystery of the distribution of this species, which is known to nest quite commonly in Greenland up to 82° 30′ on the west side, as also in Novaya Zemlya; while up to the present no details of breeding in the Spitsbergen group have been available. Similarly the presence of a large series of all the three species of geese which nest in the group in the flightless stage, thus furnishing excellent material for the study of the moults of these birds.

The eggs are of equal interest. In every case when a nest of any species of goose or duck has been taken the down and feathers have also been carefully collected. The eggs of *Branta leucopsis* have already been mentioned, but useful series of those of *B. bernicla* and *Anser brachyrhynchus* have also been taken. No eggs of the Puffin from Spitsbergen exist in collections so far as we are aware, and even Koenig's expedition failed to obtain any; but there are four in the Oxford Expedition's collection. Mandt's Guillemot (*Uria grylle mandtii*), Grey Phalarope (*Ph. fulicarius*), Purple Sandpiper (*E. maritima*) (Fig. 2), and Turnstone (*A. interpres*), are all represented in the collection, while two authentic clutches of eggs of the King Eider (*Somateria spectabilis*) are of especial value as furnishing trustworthy data for the description of eggs and down.

[*Photo, Seton Gordon.*

FIG. 2.—Purple sandpiper on nest.

In one respect the expedition was unlucky. The Spitsbergen Ptarmigan (*Lagopus hemileucurus*) was absent in 1921 from several districts where it was plentiful in 1920. Feathers and droppings of the previous year were seen in hundreds; even fragments of last year's eggs were found, but the birds were absent from their old haunts. Possibly a migratory movement, due to the open weather of the winter of 1920–21, may have been the cause of the absence of these birds, but our knowledge of this species is too fragmentary at present for us to hazard an opinion.

It must not be imagined that even now the ornithology of Spitsbergen has been worked out. The eastern side can be reached only in favourable seasons and late in the summer, and even then ice conditions vary from day to day, and the explorer may have to beat a hurried retreat or run the risk of being frozen in. Naturally its secrets can be disclosed only very gradually, and probably always very imperfectly. Even among the birds of the western coast we meet with problems which still await solution. We are still in doubt as to the status of the Snowy Owl (*Nyctea nyctea*), though the weight of evidence points to the probability of a few pairs being resident and more or less parasitic on the Ptarmigan. The long-tailed Skua (*Stercorarius longicaudus*) is also something of a problem, and the evidence with regard to its breeding not quite conclusive; and there is evidently a good deal still to be learned as to the Sanderling (*Crocethia alba*). It is hoped

Dunlin (*Erolia alpina*), hitherto known solely as an occasional visitor, has now been shown to breed in at least one district. Definite information as to the northern limit of the breeding grounds of the Ringed Plover (*Charadrius hiaticula*) and the nesting-range of the Barnacle Goose (*Branta leucopsis*) are also now available for the first time.

The skins obtained from Spitsbergen, nearly two hundred in number, are particularly interesting from the fact that they include a number of young birds in down plumage, such as Turnstone (*Arenaria interpres*), Grey Phalarope (*Phalaropus fulicarius*), Pink-footed Goose (*Anser brachyrhynchus*), Little Auk (*Plotus alle*), Glaucous Gull (*Larus hyperboreus*), and Brunnich's Guillemot (*Uria lomvia*), which are little known and not represented in most collections. Another valuable point is the

that the material brought back by the expedition will also help to clear up the vexed question as to the races of the Puffin (*Fratercula arctica*), as to which there is much division of opinion.

Some interesting observations bearing on the sexual selection theory were made by Julian S. Huxley on the Red-throated Diver (*Colymbus stellatus*), confirming and extending the conclusions reached by him in his paper on the courtship of *Podiceps cristatus* (Proc. Zool. Soc., 1914). After the birds have mated for the season, elaborate courtship ceremonies take place between the mated pair. At times the two birds swim near each other with necks arched and the open beak half submerged, uttering a special cry. At others, one bird will dive all round and about the other, sometimes emerging almost vertically from the water, as does Podiceps. The active performer in such cases may be either the male or the female.

There thus exist, as in the Crested Grebe, *mutual* nuptial ceremonies. The bird's bright colouring and special nuptial activities are connected with the bird's sexual life, but not secondary sexual characters—epigamic, but not sex-limited.

Of particular interest were the observations made on the period during which the birds are separating into pairs for the season. At this time, too, they indulge in special ceremonies, in which, however, rarely two, but usually three (or even four), individuals participate. The birds submerge the whole body with the exception of the breast; the neck is thrust slightly forward and the head held out, so that the appearance is that of a miniature Plesiosaur. In this attitude the birds plough through the water, as if running races. This ceremony was never observed later, and is certainly connected with the choice of mates. Most remarkable of all, it appears almost certain that two females may thus "compete" for a single male as well as *vice versa*. In any event, we have as a new feature that in this species the mutual or common nuptial activities of the two sexes extend even into the pairing-up period, where, if anywhere, sex-limited display and Darwinian sexual selection might be expected. This period was not observed in the previous work on Podiceps. The need for some theory of "mutual selection" to supplement the Darwinian theory of sexual selection is thus further emphasised.

Favourable opportunities for observing the nuptial activities of Phalaropes and Purple Sandpipers, in both of which reversed sexual coloration and habits occur, were unfortunately very few. It is, however, suggested that (1) the pressure of Arctic life acts as an encouragement to small size in the waders; (2) that, *per contra*, the short breeding season requires the eggs to be large, in order that their development may be hastened; this, in its turn, will limit the reduction in size of the female; (3) the female will therefore tend to be bigger than the male; (4) in almost all birds (excluding Raptores) brighter colour of the male accompanies larger size. Presumably size, pigmentation, and psychological activity are all controlled together by the endocrine secretion of the gonad. It is thus probable that larger size of the female in these species will be associated with that type of metabolism which favours more intense pigmentation; (5) the more protectively coloured male could then more advantageously undertake incubation.

A discussion of this suggestion, however, would involve the handling of large bodies of evidence. It is, in any event, clear that the condition has developed from one in which both sexes were similarly coloured, and both shared the duties of incubation.

To sum up, we have here a series of nearly three hundred skins as well as about five hundred eggs, together with full diaries and field notes from members of the expedition. It is hoped that the reports on these collections will embody what is already known of the Spitsbergen and Bear Island group, and provide us with a dependable and handy manual on the birds of the archipelago. The coming of the oil engine has already affected the fauna considerably, and probably will do so even more in the future, and it is important to record the changes of the last ten or fifteen years. Koenig's fine work is bulky and expensive, and a concise account of the bird life, embodying the results of the present expedition, would be a most valuable work of reference as well as a permanent memorial of what is perhaps the only serious ornithological work undertaken by English men or women in the Arctic since Mr. Henry Pearson's last voyage to Russian Lapland more than twenty years ago, with the sole exception of Miss Haviland's adventurous journey to the mouth of the Yenisei in 1914.

The Present Position of the Theory of Descent, in Relation to the Early History of Plants.[1]

By DR. D. H. SCOTT, F.R.S.

IT has long been evident that all those ideas of evolution in which the older generation of naturalists grew up have been disturbed, or, indeed, transformed, since the re-discovery of Mendel's work and the consequent development of the new science of genetics. Not only is the "omnipotence of natural selection" gravely impugned, but also variation itself, the foundation on which the Darwinian theory seemed to rest so securely, is now in question.

The small variations, on which the natural selectionist relied so much, have proved, for the

[1] Abridged from the presidential address delivered to Section K (Botany) of the British Association at Edinburgh on September 9.

most part, to be merely fluctuations, oscillating about a mean, and therefore incapable of giving rise to permanent new types. The well-established varieties of the Darwinian, such as the countless forms of *Erophila verna,* are now interpreted as elementary species, no less stable than Linnean species, and of equally unknown origin. The mutations of De Vries, though still accepted at their face value by some biologists, are suspected by others of being nothing more than Mendelian segregates, the product of previous crossings; opinion on this subject is in a state of flux. In fact, it is clear that we know astonishingly little about variation. Dr. Lotsy, indeed, proposes to dispense with variation altogether, and to find the true origin of species in Mendelian segregation; inheritable variability, he believes, does not exist; new species, on his bold hypothesis, arise by crossing, and so, as he points out, we may have an evolution, though species remain constant. Thus everything apparently new depends on a re-combination of factors already present in the parents. "The cause of evolution lies in the interaction of two gametes of different constitution."

I am aware that very surprising results have been obtained by crossing. Nothing could well have been more striking than the series of Antirrhinum segregates which Dr. Lotsy showed us some years ago at a meeting of the Linnean Society; and now we hear of an apetalous Lychnis produced by the crossing of normally petaloid races. We do not know yet to what extent that sort of thing goes on in Nature, or what chance such segregates have of surviving. Still, if one may judge by Dr. Lotsy's experimental results, ample material for natural selection to work on might be provided in this way.

Dr. Lotsy's theory that new species originate by Mendelian segregation, if true, would have the advantage that it would make quite plain the meaning of sexual reproduction. Hitherto there has been a good deal of doubt; some authorities have held that sexual reproduction stimulated, others that it checked, variation. But, if we eliminate variation, and rely solely on the products of crossing, we get a clear view—"species, as well as individuals, have two parents"; sexual reproduction can alone provide adequate material for new forms, and can provide it in unbounded variety.

Again, though Dr. Lotsy himself is far from sanguine on this point, the crossing theory might be helpful to the evolutionary morphologist, for breeding is open to unlimited experiment, and we might hope to learn what kinds of change in organisms are to be expected. For example, the Lychnis experiment shows how easily a petaloid race may become apetalous. Such results might ultimately be a great help in unravelling the course of evolution in the past. We should gain an idea of the transformations which might actually have taken place, excluding those which were out of the question. At present all speculation on the nature of past changes is in the air, for variation itself is only an hypothesis, and we have to decide, quite arbitrarily, what kind of variations we think may probably have occurred in the course of descent. One need only recall the various theories of the origin of the seed from the megasporangium to realise how arbitrary such speculations are.

But, while recognising certain advantages in the theory of the origin of species by crossing, it is not for me to pronounce any opinion as to its truth. It is only the present position of the question that concerns us to-day. Some modern geneticists believe that there is evidence for mutation by the loss of factors, apart from the effects of crossing. Dr. Lotsy considers that such changes, if proved, can afford no explanation of progressive evolution. "Evolution by a process of repeated losses is inconceivable." It has, however, been pointed out by Dr. Agnes Arber, in her recent admirable book on water-plants, that, on any theory of evolution, "what organisms have gained in specialisation they have lost in plasticity." This is true, but it is not clear that this admitted loss of potentialities is the same thing as the loss of factors, in the sense of genetics.

Turning for a moment to Darwin's own theory of the origin of species by means of natural selection, the efficacy of the latter in weeding out the unfit is, of course, still acknowledged, and some geneticists allow it a considerable *rôle*. But there is a strong tendency in these days to admit natural selection only as a "merely negative force," and as such it has even been dismissed as a "truism." Now Darwin's great book was most certainly not written to enunciate a truism. He regarded natural selection as "the most important, but not the exclusive, means of modification" ("Origin of Species," p. 4). It was the continual selection of the more fit, the "preservation of favoured races," on which he relied, and not the mere obvious elimination of the unfit, and this great idea (so imperfectly understood by many of his contemporaries and successors) he worked out with astonishing power, in the light of the changes which man has produced, with the help of his own artificial selection.

It may be that the theory of natural selection, as Darwin and Wallace understood it, may some day come into its own again; certainly it illuminated, as no other theory has yet done, the great subject of adaptation, which to some of us is, and remains, the chief interest of biology. But in our present total ignorance of variation and doubt as to other means of change, we can form no clear idea of the material on which selection has had to work, and we must let the question rest.

For the moment, at all events, the Darwinian period is past; we can no longer enjoy the comfortable assurance, which once satisfied so many of us, that the main problem had been solved—all is again in the melting-pot. By now, in fact, a new generation has grown up that knows not Darwin.

Yet evolution remains—we cannot get away

from it, even if we hold it only as an act of faith, for there is no alternative, and, after all, the evidence of palæontology is unshaken. I have thought it fair to lay stress on the present state of uncertainty in all that concerns the origin of species. On another occasion I even ventured to speak of the return of "pre-Darwinian chaos." But out of this chaos doubtless light will come. Last year, during a joint discussion on genetics and palæontology, I specially remember a remark by Miss Saunders, our then president, that Mendelism is a theory of heredity, not of evolution—a caution not unneeded, though, as the crossing hypothesis shows, the connection between the two conceptions may prove to be a very close one.

Genetics is rendering the greatest service to biology generally in ensuring that organisms shall be thought of as races, not as isolated individuals, mere chemical and physical complexes, at the mercy of the environment. The whole tendency of modern work is to show that in living things heredity is supreme. An organism is what it is by virtue of the constitution of the germ-plasm derived from its parents. Dr. Church says that "the more fundamental reactions, as expressed in morphological units of construction, have been established as constants beyond any hope of change." This statement is an important one for the palæontologist, for all our attempts to trace descent rest on the assumption that, in a general sense and as regards certain well-established characters, "like breeds like."

The question, What do we mean by a "species"? is far too difficult a matter to discuss now. Whatever we may think of Darwin's theory, his "Origin of Species" is at any rate a classic, and I believe we cannot do better than continue to use the word in the same sense as Darwin used it—*i.e.* essentially in the sense of a Linnean species.

That many Linnean species are real units of a definite order is generally admitted. Dr. Lotsy himself dwells on their distinctness, which depends on their usually not inter-crossing, and appears to be shown by the fact that among animals members of the same species recognise each other as such and habitually breed together. Such habitual breeding together under natural conditions is perhaps the best test of a species in the Linnean sense. "The units within each Linneon (= species) form an inter-crossing community." (Lotsy.) He adds: "Consequently it is Nature itself which groups the individuals to Linneons." These "pairing communities" have recently been re-christened by Dr. Lotsy "syngameons," a good name to express this aspect of the old "species."

I do not propose in these brief remarks to venture on that well-worn subject the inheritance of acquired characters—*i.e.* of such characters as are gained during the lifetime of the individual by reaction to the environment. There has always been a strong cross-current of opinion in favour of this belief, especially, in our own time, in the form of "unconscious memory," so ably advocated by Samuel Butler and supported by Sir Francis Darwin in his presidential address to the British Association at Dublin. Professor Henslow, as we all know, is a veteran champion of the origin of plant structures by self-adaptation to the environment. On the other hand, some geneticists roundly deny that any inheritance of somatically acquired characters can take place. In any case, the evidence, as it seems, is still too doubtful and inadequate to warrant any conclusion, so, however fascinating such speculations may be, I pass on.

To bring these introductory remarks to a close, we see that while the theory of descent or evolution is undisputed, we really know nothing certain as to the way in which new forms have arisen from old. During the reign of Darwinism we commonly assumed that this had happened by the continual selection of small variations, and we are no longer in a position to make any such assumption.

We have been told on high authority that "as long as we do not know how *Primula obconica* produced its abundant new forms it is no time to discuss the origin of the Mollusca or of Dicotyledons." (Bateson.) Yet this is just the kind of speculation in which a palæontologist is apt to indulge, and if kept off it he would feel that his occupation was gone! However, so long as we may believe, as already said, that, on the whole, like breeds like, that grapes do not spring from thorns or figs from thistles, there is perhaps still sufficient basis for some attempt to interpret the past history of plants in terms of descent. But certainly we have learnt greater caution, and we must be careful not to go far beyond our facts, and, in particular, to avoid elaborate derivations of one type of structure from another where the supposed transitional forms have but a purely subjective existence; we have realised the difficulty of tracing homologies. We may still be allowed to seek affinities, even where we cannot trace descent. And though we may sometimes go a little beyond our tether and give rein to bolder speculations, there is no harm done so long as we know what we are doing, and there may be even some good in such flights if our scientific use of the imagination serves to give life to the dry bones of bare description. On this subject I am somewhat more optimistic than Dr. Lotsy, who, abandoning his "Stammesgeschichte" point of view, has dismissed all attempts at phylogenetic reconstruction as "fantastic."

There are some questions of the highest interest that at present can scarcely be approached in any other but a speculative way. Within the last year or two new points of view have thus been opened out. For example, Dr. Church's able essay on "Thalassiophyta and the sub-aerial transmigration" has brought vividly before us the great change from marine to terrestrial life. Dr. Church puts the actual conquest of the land in the foreground. We watch the land slowly rising toward the surface of the primeval ocean,

the rooted sea-weeds succeeding the free-swimming plankton, and then the continents slowly emerging and the drama of the transmigration, as the plants of the rock-pools and shallows fit themselves step by step for sub-aerial life when the dry land appears. It is a striking picture that is thus displayed to our view—whether in all respects a faithful one is another question; we must not expect impossibilities. The doubts which have been raised relate first to the assumed world-wide ocean, which seems not to be generally accepted by geologists. If continental ridges existed from the first (*i.e.* from the original condensation of watery vapour to form seas), the colonisation of the land may have followed other lines and have happened repeatedly. Perhaps, after all, that would not greatly affect the botanical aspects of the transmigration.

Dr. Church believes that the chief morphological characters of the land flora were first outlined in the sea; that such characters were not newly assumed after transmigration, but that they merely represent an adaptation to sub-aerial conditions of a differentiation already attained at the phase of marine phytobenthon (rooted sea-weeds). At the same time it is not suggested that any existing class of sea-weeds can be taken as representing the ancestry of the land flora; the transmigrant races are, as Algæ, extinct—they may have been Green Algæ of a high grade of organisation, on a level now perhaps most nearly represented by the highest of the Brown Sea-weeds.

Thus the transmigrants, which were destined to become the parents of the land flora, are pictured as already highly organised and well differentiated plants, which only needed to provide themselves with absorptive instead of merely anchoring roots, and with a water-conducting system (xylem and stomata) in order to fit themselves for sub-aerial life, while, on the reproductive side, the great change remaining to be accomplished was the adaptation of the spores to transport by air instead of by water.

Some botanists find a difficulty in accepting the suggestion that plants already elaborately fitted out for a marine life could have survived the transition, however gradual, to a totally different environment. Such thinkers prefer to believe that lower forms may have been more adaptable, and that morphological differentiation had, in a great degree, to start afresh when the land was first invaded. My own sympathies, I may say, are here with Dr. Church, for I have long inclined to the belief that the vascular plants were, in all probability, derived from the higher Thallophytes. The view of the late Prof. Lignier, now so widely accepted, that the leaf, at least in the megaphyllous or fern-like vascular plants, was derived from specialised branch-systems of a thallus, assumes, at any rate, that the immediate ancestors possessed a well-developed thallus, such as is now known only among the higher Algæ.

The question now arises, how far have we any evidence from the rocks which may bear on the transmigration and on the nature of the early land flora? Quite recent discoveries, especially those from the famous Rhynie Chert-bed, have shown that in Early Devonian times certain remarkably simple land-plants existed, which in general configuration were no more advanced than some very ordinary sea-weeds of the present day. At the same time these plants were obviously fitted for terrestrial life, as shown by the presence of a water-conducting tissue and stomata, and by the manifestly air-borne spores. These simplest land-plants are the Rhyniaceæ (Rhynia and Hornea), while the third genus, Asteroxylon, was more advanced and further removed from any possible transmigrant type.

Dr. Arber was so impressed by the primitive character of Rhynia (the only one of these genera then known) that he boldly called it a Thallophyte, while recognising, in respect of anatomical structure, an intermediate position on the way to Pteridophyta. This is not really very different from the view taken by the investigators themselves, though they call the plants Pteridophytes, which they certainly are if we go by internal structure rather than external morphology. But if, as Kidston and Lang suggest, the Rhyniaceæ "find their place near the beginning of a current of change from an Alga-like type of plant to the type of the simpler vascular Cryptogams," they must have been very primitive indeed, and might even be regarded as fairly representing the true transmigrants which had not long taken to the land.

It is true that the Middle Devonian is much too late a period for the original transmigration (I believe there is some evidence for land-animals in the Lower Silurian), but one may argue that some of the transmigrant forms may have survived as late as the Devonian, just as the Selaginella type seems to have gone on with little change from the carboniferous to the present time. There must have been many such survivals of earlier forms in the Devonian period, if Arber was right in regarding all the characteristic plants of the Psilophyton flora as "much more probably Thallophyta than Pteridophyta." There is, in fact, no doubt that the earlier Devonian flora is turning out to have been on the whole more peculiar and more unlike the higher plants than we realised a few years ago. The Early Devonian plants cannot usually be referred to any of the recognised groups of Pteridophytes, and this is not owing to our imperfect knowledge, for it is just in those cases where the plants are most thoroughly known that their unique systematic position is most manifest. Arber called all the plants in question "Procormophyta"—an appropriate name. As Kidston and Lang point out in their later work, the three groups—Pteridophyta, Bryophyta, and Algæ—are brought nearer together by the Rhynie fossils.

Yet there is evidence that about the same period stems with the highly organised structure of Gymnospermous trees already existed. I refer to

remains of which *Palaeopitys Milleri*, from the Middle Old Red Sandstone of Cromarty, is the type. We need much further investigation of these higher forms of Early Devonian vegetation, but we know enough to impose caution on our speculations.

The Rhyniaceæ, at all events, were leafless and rootless plants. In one species of Rhynia and in Hornea the aerial stems are entirely without any appendages, while in the other Rhynia there are hemispherical swellings, which have been identified by Arber with certain states of the spines in Psilophyton. The emergences of *R. Gwynne-Vaughani* have been interpreted as nascent leaves, but more recent observations, showing their late histological origin, have rendered this hypothesis very doubtful.

In Asteroxylon, a higher plant altogether, the stem is clothed with quite distinct leaves, though they are somewhat rudimentary as regards their vascular supply. Have we, in these plants, and others of contemporary date, the first origin of the leaf from a mere non-vascular emergence, or had reduction already begun, so that in Rhyniaceæ, for example, the leaves were in the act of disappearance? In the former case we should be assisting at the birth of Lignier's phylloids, the microphylls of the Lycopod series.

But the opposite view may also be tenable. We have already seen that these plants have been referred both to the Pteridophytes and the Thallophytes; they also show signs of Bryophytic affinities, and I understand that it has even been proposed to include them in the Bryophyta, in which case every possible view will be represented. The Sphagnum-like structure of the columellate sporangium or sporogonium of Hornea and Sporogonites may justify the Bryophytic attribution, and it is then, of course, easy to extend it to Rhynia. If we were to adopt this opinion we should probably have to regard these simple Devonian plants as representing stages in the reduction of the sporophyte to a sporogonium, the leaves being already nearly or quite lost, while the branched thallus was still much in excess of the simple seta of the modern Moss or Hepatic. Naturally we know nothing of the gametophyte, so that the material for comparison is limited. Kidston and Lang, however, have recently pointed out that the presence of spore-tetrads clearly indicates the existence of a gametophyte.

I make no attempt to decide between these views. There can be no reasonable doubt that the Psilophytales generally represent an earlier phase of cormophytic life than any of the groups previously recognised. But we must not assume that *all* their characters were primitive. It has been pointed out that the Rhyniaceæ were peat plants, and that the peat flora is apt to be peculiar. Under such conditions it is not improbable that a certain amount of reduction may have already been undergone, though this is not the view taken by the investigators.

The recent work on the Early Devonian flora has wide bearings. It has long been noticed that among the fossils of that period no typical fern-fronds are found. Those remains which are most suggestive of fern-like habit consist merely of a naked, branched rachis. It used to be assumed that the absence of a lamina might be explained by bad preservation. But, as Prof. Halle points out, the chief reason for condemning the preservation as bad was the fact that a lamina was absent!

The evidence really seems to indicate that the so-called fronds of that age did not possess a leaf-blade. As Prof. Halle says: "In the Lower Devonian, finally, we find frond-like structures bearing sporangia, but no fronds with developed laminæ. One can hardly escape the conclusion that the 'modified' fertile fronds may represent the primitive state in this case and that the flattened pinnules are a later development, as suggested by Prof. Lignier." These naked fronds may, in fact, be regarded as the little-differentiated branches of a thallus.

The evidence, as at present understood, seems to suggest that, in the earlier Devonian flora, ferns, properly so called, may not yet have been in existence. The predecessors of the ferns were there, no doubt, but not, so far as we know, the ferns themselves. Yet it seems that highly organised stems of a gymnospermous type were already present at about the same period. Thus the evidence from the older Devonian flora, so far as it goes, materially supports the opinion that the seed plants cannot have arisen from ferns, for the line of the Spermophyta seems to have been already distinct at a time when true ferns had not yet appeared.

The idea, which I once advocated, that the Gymnosperms were derived, through the Pteridosperms, from the ferns must, I think, be given up, on grounds which were stated two years ago at the Bournemouth meeting of the Association. It is safer to regard the Pteridosperms, and therefore the seed plants generally, as a distinct stock, probably as ancient as any of the recognised phyla of vascular Cryptogams, and derived from some unknown and older source. At the same time the striking parallelism between the Pteridosperms and the true ferns must be recognised. These views are essentially in agreement with those previously expressed by my friend Dr. Kidston.

The significance of the Pteridosperms has perhaps been somewhat misunderstood. It now seems that they do not, as some of us once imagined, indicate the descent of the seed plants from ferns, but rather show that the seed plants passed through a fern-like phase; they ran a parallel course with the true cryptogamic ferns, and, like them, sprang from some quite early race of land plants, such as Rhynie has revealed to us. But the phylum was never any more fern-like than the Pteridosperms themselves.

On our hypothesis, the Upper Palæozoic phyla, with which we have to reckon, are the Pteridо-

sperms (representing the early phase of the seed plants), the ferns, the Sphenophylls, the Equisetales, and the Lycopods. These five lines were probably all well differentiated in the Upper Devonian flora.

When we get back to the Middle and Lower Devonian the case is completely altered. Not one of the five phyla is here clearly represented, unless it be the Spermophyta; for these we have the evidence of apparently gymnosperm-like stems. Thus the field is left absolutely open to speculation. We may imagine either that the various phyla converged in some early vascular stock (illustrated by the Psilophytales), or that they ran back in parallel lines to independent origins among the transmigrant Algæ and, perhaps further still, to separate races of purely marine plants. Both views are represented in the publications of recent authors.

Dr. Arber, in his "Devonian Floras," maintained the early existence of three distinct lines of descent: the Sphenopsida, Pteropsida, and Lycopsida. Each of the three lines is described as descended from thallophytic Algæ of a distinct type. Thus Arber's view was decidedly polyphyletic.

Dr. Church, from quite a different point of view, arrives at somewhat similar conclusions, but he goes further. He says: "Speaking generally, it appears safer to regard a 'race' or 'phylum' as the expression of a group of organisms which derived their special attributes from the equipment of a preceding epoch, if not in one still further back. Thus all the main lines of what is now land flora must have been differentiated in the Benthic epoch of the sea (*i.e.* as algal lines), as all algal lines were differentiated in the Plankton phase. The possibility is not invalidated that existing groups of land flora may trace back their special line of progression to the flagellated life of the sea, wholly independently of one another (Pteridophyta)."

Thus the idea of independent parallel lines of descent is carried to its extreme limit. "Each phylum goes back the whole way, without any connection with anything else." Of course, this thorough-going polyphyletic conception is involved in the doctrine already mentioned that morphological differentiation was attained in the sea before the transmigration.

I have cited Dr. Arber and Dr. Church as independent representatives, approaching the question from quite different sides, of the polyphyletic or parallel-phyla hypothesis. The opposite view, of convergent monophyletic races, is also well supported. Prof. Halle, after speaking of the possible relation of the Psilophyton type to Lycopods on one hand and ferns on the other, adds: "From this point of view the whole pteridophytic stock would be monophyletic, the Lycopsida and the Pteropsida being derived from a common form already vascular. It would not thus be necessary to assume a parallel evolution of a similar vascular system along two different lines."

Kidston and Lang, in the light of their Rhynie discoveries, regard Halle's survey as "a fair statement of the present bearing of the imperfectly known facts." They add: "The geological age and succession of the Early Devonian plants are, on the whole, consistent with the origin of the various groups of vascular Cryptogams from a common source." We have already referred to the bryophytic features, which have been recognised in the Rhyniaceæ. Kidston and Lang make use of these to extend their tentative conclusions to the Bryophyta. In concluding their third memoir they say: "In Rhynia and Hornea we have revealed to us a much simpler type of vascular Cryptogam than any with which we were previously acquainted. This type suggests the convergence of Pteridophyta and Bryophyta backwards to an algal stock. The knowledge of Asteroxylon confirms and enriches our conception of a more complex but archaic type of the vascular Cryptogams, which supports the idea of the divergence of the great classes of Pteridophyta from a common type, and links this on to the simpler Rhyniaceæ." The monophyletic view, though stated with appropriate caution, could not be more clearly expressed

It is evidently impossible to decide between the two theories in the present state of our knowledge; we are now only beginning to acquire some conception of the vegetation of Early Devonian times. The discovery, however, of the existence at that period of an unexpectedly simple race of vascular plants to some extent favours a monophyletic interpretation. To some minds, too, the important points in which all existing Pteridophyta, however diverse, agree will still suggest a common origin not too remote. Among such common characters may be mentioned the alternation of generations with the sporophyte predominant; the development both of the spores and the sexual organs; and the histology, especially of the vascular system and the stomata. The community of reproductive phenomena is explained by Dr. Church on the principle that reproductive phases are inevitable and are therefore the same in all phyla. A like explanation may to a certain extent be applicable to somatic features, some of which may be the necessary consequences of the sub-aerial transmigration. Thus a polyphyletic hypothesis may no doubt be justified, but it urgently needs to be supported by further evidence of the actual existence of separate stocks among the earliest available records of a land flora.

The study of fossil botany has led to results of the utmost importance in widening our view of the vegetable kingdom and helping to complete the natural system, to use Solms-Laubach's old phrase once more. One need mention only the Mesozoic Cycadophytes, the Cordaitales, the Pteridosperms, the Palæozoic Lycopods and Equisetales, the Sphenophylls, and now, most striking of all, the Psilophytales, to recall how much has been gained. We have indeed a wealth of accumulated facts, but from the point of view

of the theory of descent they raise more questions than they solve. In this address I have briefly touched on some of the most general and most speculative problems in the hope of giving an opening for discussion. It might have been more profitable to deal in detail with definite facts of observation, but recent discoveries have brought us face to face with the great questions of descent among plants. However imperfect our data may be, both as regards the method and the course of evolution, the problems suggested, nevertheless, make urgent claims on our attention.

The Shackleton-Rowett Oceanographic and Antarctic Expedition.

By Dr. Hugh Robert Mill.

THE Shackleton-Rowett expedition, the preliminary plans of which were outlined in NATURE for July 7, p. 602, left St. Katherine's Dock in the *Quest* on Saturday, September 17, remained at Sheerness for a few days to complete the fitting of the wireless telegraphy apparatus, and sailed from Plymouth on Saturday last, September 24, at 5 p.m.

So much publicity has been given to the plans and prospects of this expedition, and such stress laid by headlines and large type on the minor incidents of preparation and departure, that one reader might be excused if he viewed it all as what, for lack of a more ancient and decorous term, he might be tempted to call a mere stunt; while another of a more generous disposition could scarcely be blamed for looking on it as a great oceanographical expedition. As a matter of fact, it is designed to be neither the one nor the other. The *Quest* is a very small vessel, and she has started on a very big voyage, full of dangers and risks that it is probable no committee of geographical or nautical experts would recommend any selected leader to undertake; but no such committee was created or consulted, and Sir Ernest Shackleton bears on his own broad shoulders all the responsibility for the plan of the expedition, the choice of his comrades, and the fight with the very real difficulties of a great and romantic adventure. Even if no scientific results were aimed at, this revival of the old spirit of maritime knight-errantry which has invigorated our sea-history since Elizabethan days is a thing to be proud of and grateful for in an age of disillusion, low ideals, and love of ease. The members of the expedition include the most experienced polar explorers and men who have been trained in the almost incredible hardships of mine-sweepers, submarines, and "Q"-ships.

Sir Ernest Shackleton has, however, a very clear and useful programme of scientific work, in which he sought the advice and secured the help of many authorities, including the Admiralty and the Air Ministry. He has not tried to make the *Quest's* voyage a second *Challenger* expedition, or in any way to anticipate the renewal of the large-scale oceanographical research ably sketched out by Prof. Herdman and wisely postponed to a more convenient, and, we trust, not very far distant, season. The *Quest* is fitted with the latest machines for deep-sea soundings, and if her voyage is completed along the route projected the results should be of great importance, especially in the Enderby quadrant of the Antarctic. Some may be inclined to doubt the possibility of taking exact soundings from so small a vessel in high seas, but in the early days of telegraph-cable surveying with the crudest appliances excellent results were obtained, in depths far more than a thousand fathoms, from sailing vessels smaller than the *Quest*. No surveying ship probably has been better equipped for fixing accurate positions, as it should be possible to rate the chronometers by wireless time-signals during the greater part of the cruise. Deep-sea temperature observations and the collection of water-samples to be preserved for examination on shore should also be possible. The size of the ship makes it hopeless to attempt deep-sea dredging or trawling, but shallow-water dredging will no doubt be carried out when occasion offers, and the collection of plankton will be greatly facilitated by the low freeboard and comparatively slow speed of the ship.

Much interest attaches to the meteorological work to be done on board, and especially to the upper-air investigations for which provision has been made by the Meteorological Office. The small seaplane carried by the *Quest* will be very useful in piloting the vessel in ice and in the search for doubtful islands *if* it can be put together successfully and transferred safely from the ship to the sea and back again; but this part of the equipment must be viewed as an experiment the success of which is not to be acclaimed until it has been proved. Magnetic observations will, it is hoped, be made a special feature of the scientific work, and for the first time, we believe, a gyroscopic compass will be carried into high latitudes, where its indications should be of extreme value, as the track should carry the *Quest* across the region of maximum change of variation where the magnetic needle is of least value. Opportunities will doubtless occur for magnetic work on ice-floes and perhaps also on islands if local attraction is not too strong.

The *personnel* of the Expedition was announced as follows:—

Sir Ernest Shackleton, leader and captain; Commander Frank Wild, second-in-command; Commander Frank Worsley, hydrographer and sailing-master; Lieut.-Commander D. G. Jeffrey, navigator; Major A. H. Macklin, surgeon; Capt. L. D. A. Hussey, meteorologist; Lieut. A. J. Kerr, chief engineer; Major R. Carr, airman; Capt. G. V. Douglas, geologist; Capt. G.

Wilkins, naturalist; Mr. J. C. Bee-Mason, photographer and kinematographer; Mr. G. Smith, second engineer; Mr. J. Dell, electrician; Mr. Harold Watts, wireless operator; D. Ericson, gunner; C. J. Green, cook; Boy Scouts N. E. Mooney and J. W. Marr. The members of the scientific staff enumerated above will also work the ship, and on leaving Plymouth two additional members were shipped for the first part of the voyage in the persons of Mr. Gerald Lysaght and Mr. McLeod. Of the complete ship's company of twenty all told, no fewer than five accompanied Sir Ernest Shackleton on his Antarctic expedition in the *Endurance* in 1914.

Obituary.

Dr. Walter George Ridewood.

DR. WALTER G. RIDEWOOD, whose sudden death occurred on September 19, was born in London on February 1, 1867. He was educated at Enfield Grammar School, of which his father, Mr. W. S. Ridewood, was headmaster for many years. He was at the Royal College of Science from 1883 to 1887, becoming an associate and taking first classes in both biology and geology. In 1888 he took his B.Sc. degree in the University of London, with first-class honours in zoology, and in 1897 he became D.Sc. In the meantime, in May, 1888, he had been appointed assistant to the director at the British Museum (Natural History), where he was employed in making the wonderful series of anatomical preparations exhibited in the Central Hall of that institution. In this kind of work Dr. Ridewood was without rival, his extraordinary manual skill and technical knowledge being supplemented by a thorough grasp of the principles of morphology and a close acquaintance with its literature. He also organised and prepared several special exhibitions, among the most important being the Darwin Centenary Exhibition and the series of preparations illustrating the different modes of flight in the animal kingdom. This series is still on exhibition, and is an excellent example of his work. For these and other exhibitions he prepared valuable illustrated guide-books. He severed his connection with the British Museum in 1917, after twenty-nine years' service, his resignation being greatly regretted by his colleagues.

In addition to, and for the most part relating to, his work in the museum Dr. Ridewood published a long series of valuable memoirs, mostly dealing with the comparative anatomy of the Vertebrata. Only some of the more important of these can be referred to: "On the Cranial Osteology of the Teleostei" (five papers in the Proc. Zool. Soc., 1904, and in the Journ. Linn. Soc., vol. 29: these were intended to be used in a general work on the osteology of fishes, never published); "On the Air-bladder and Ear in the British Clupeoid Fishes" (*Journ. of Anatomy*, vol. 26); "On the Structure and Development of the Hyobranchial Skeleton and Larynx in Xenopus and Pipa" (Journ. Linn. Soc., vol. 26: this was his thesis for the D.Sc. degree). He also wrote on a new species of Cephalodiscus from the Cape Seas, and on the Pterobranchia of the Antarctic (*Discovery, Scotia,* Australasian, and *Terra Nova* Expeditions). His chief paper relating to the Invertebrata is the "Monograph on the Gills of the Lamellibranchia" (Phil. Trans., 1903); this he illustrated by a series of models in the British Museum. His last published work is an important memoir, "On the Calcification of the Vertebral Centra in the Sharks and Rays" (Phil. Trans., 1921). In this he was able to show that Hasse in his great work on the same subject had "overestimated the importance of the disposition of the calcified masses and laminæ in the centrum as a taxonomic feature." Another completed paper on the development of the skull in the whalebone whales remains to be published.

Dr. Ridewood was a man of a singularly quiet and retiring disposition, which perhaps in some cases led to his real character being misunderstood. Actually his reticence was a mask covering a genuine kindliness which often showed itself in the great amount of trouble he would take to help anyone who asked for his advice and assistance. During the war he drove a Red Cross ambulance in France for nearly two years.

Apart from zoology, Dr. Ridewood's chief interest was in music. He was an extremely good performer on the flute, and for many years was a member of various amateur orchestras, especially of the Strolling Players. He made a thoroughly scientific study of his favourite instrument, but does not seem to have published anything on the subject.

He was for twenty-three years lecturer on biology in the Medical School of St. Mary's Hospital, London, and was reader in zoology in the University of London. He was also a life member of the Linnean, Geological, Zoological, and Malacological Societies. C. W. A.

Notes.

We learn from the *Times* that Sir Thomas Holland, who recently resigned his post as Minister of Industries in the Governor-General of India's Council as a protest against the suspension of prosecution in connection with alleged corrupt practices in the supply of munitions, left Simla on Friday last for England. The whole facts of the case are not before us, but so far as we can make them out Sir Thomas Holland has been sacrificed to political expediency. In a recent speech the Viceroy, Lord Reading, suggested that the trouble would not have arisen had the post of Minister of Industries been filled by a lawyer

instead of a man of science, and we may put our own interpretation upon this view. Sir Thomas Holland appears, however, to have consulted two members of the Viceroy's Council, one of whom was probably the legal member, before censuring the official and firms involved in the Calcutta munitions case, and the gravity of his offence was that he did not consult the Viceroy himself. But surely it is the duty of the legal member of the Council to advise his non-legal colleagues, and if Sir Thomas Holland had his approval that ought to have been sufficient. If nothing can be done in India without consulting the Viceroy personally, administration will be slower than ever. The truth seems to be that Sir Thomas Holland made many enemies by his attacks on profiteers, and their hostility, with that which lawyer administrators often display towards scientific men who enter what they consider to be their own special preserves, has resulted in the removal of one who was to them a troublesome Minister. Whatever may be said in favour of the strictly legal view of the case, common sense is on the side of Sir Thomas Holland, who may be assured that his action will be supported by scientific workers everywhere. The claim that a Minister of Industries should necessarily be a lawyer is one against which we must enter the strongest protest both on account of science and of efficiency. We trust that when Parliament meets the whole question will be raised in the interests of probity and justice.

THE announcement in the *Times* of September 24 of the successful synchronisation of speech and action in kinematography by means of photographic films bearing suitable sound records is the natural outcome of the work expended on this problem in numerous different countries. Sweden, through MM. Bergland and Frestadius, has apparently been fortunate enough to reach success first. It is indeed surprising that the achievement has been so long delayed. Speaking-films, apart from synchronisation, have been in existence for a long time, having been first made by Ernst Rühmer about 1900, and called by him the "photographophone." Rühmer made his films by photographing upon them the fluctuating light proceeding from a "speaking arc," and the reproduction was effected by making use of the well-known property of selenium of controlling a telephonic current when actuated by variable illumination. More recently (Proc. Phys. Soc., vol. 32, p. 78) Prof. A. O. Rankine has made speaking-films by a different method, in which the voice imposes fluctuations of intensity on a beam of light issuing from a constant source, the reproduction from the film record again being by means of selenium. The whole problem is closely related to telephony by light, of which a description was given in NATURE of February 5, 1920 (vol. 104, p. 604). In photo-telephony the speech is transmitted by light and reproduced immediately; in speaking-films a photographic record is made for future reproduction. The *Times* article does not make quite clear by what process M. Bergland makes the sound-film, but it probably does not differ fundamentally from those previously used. The novelty of M. Bergland's work appears to be the successful realisation of synchronism between the picture-bearing and the sound-record-bearing films. This has been done by the obvious method of running the two films on the same shaft, both during the taking of the double record of action and speech and during reproduction. In addition, sufficient valve amplification to actuate a loud-speaking telephone has been successfully applied to the selenium-controlled currents.

A PUBLIC meeting was held in Edinburgh on September 13 last under the auspices of the National Union of Scientific Workers, when Prof. H. Levy delivered an address entitled "The Function of the Scientist in Organised Research." Prof. Levy laid stress on the fact that by research new fields of inquiry were being opened up and new crafts being created. The status of the work itself, as well as that of the worker, must therefore receive consideration. Any tendency to make research a commercial undertaking was deprecated as liable to stifle investigations of fundamental importance, though possibly of an abstract nature. For the direction of research it was suggested that the best administrators would be men of scientific attainments who understood the conditions best adapted for good work; men of science must therefore be trained in administration. On the other hand, the idea of training the administrator in research was regarded as out of the question, the two faculties being, when approached in this order, diametrically opposed. As regards the status of the research worker, it was maintained that such security of tenure must be granted as would admit of unfettered criticism, and that the remuneration attached to appointments of a scientific nature, whether administrative or practical, should correspond with that attached to posts of a similar grade in other branches of Government service. The co-operation of men of science of all kinds was necessary in order to promote the interests of research.

DISPATCHES from Col. Howard Bury to the *Times* describe the further efforts of the Mount Everest Expedition to find a practicable route to the summit of the mountain. Unfavourable weather at the end of August having interfered with mountain climbing, Col. Howard Bury and Mr. Wollaston explored the lower valley of the Kamachu from the expedition's base at Kharta. They crossed the Samjunla at 15,000 ft. and the Chogla at 16,100 ft., reaching a remarkable lake called Ruddamlamtso, which is regarded as holy and is the destination of annual pilgrimages. Two thousand feet above the lake is the village of Sakideng, once a place of considerable size, but now practically deserted since a pestilence wiped out the inhabitants. From Sakideng Col. Bury descended the Kama and Kamachu valleys, which were found to be densely forested. The Arun Valley was reached at about 7500 ft. The village of Lungdoe, some 4000 ft. above the river, was found to lie in a region of great fertility and luxuriant crops of millet, cucumbers, and pumpkins.

LATER news from Col. Howard Bury, published in the *Times*, is to the effect that the approach to Mount Everest up the Kamachu or Shinchu Valley, indicated

by the local inhabitants, proved to be useless. No possible way was discovered of ascending the cliffs surrounding the Kamgshung glacier. Attention was then turned to the upper valley of the Kharta, about which nothing could be learnt from the inhabitants. Ascending the glacier at the head of the valley the explorers ascended gentle slopes through deep snow to a col at 23,000 ft., from which it appeared possible to reach the northern ridge of Mount Everest. Soft snow and warm weather prevented any further advance, so that efforts were concentrated on preparing a base as high as possible. With this end in view a camp was established about eighteen miles up the Kharta Valley at about 17,500 ft., a second camp at about 20,000 ft., and a third camp at the 23,000-ft. col. It is possible a fourth camp was to be made between 23,000–24,000 ft. on the slopes of Mount Everest itself. Messrs. Mallory and Bullock left Kharta on August 31 for the advanced camp to await suitable weather conditions. Mr. Raeburn has rejoined the expedition.

THE *Quest*, with the Shackleton-Rowett Expedition on board, was given an enthusiastic send-off on leaving Plymouth for the south on September 24. The first stage of the journey is to the Salvage Island, a small group of rocky islets occasionally visited by Portuguese fishermen, but otherwise uninhabited, lying 160 miles south of Madeira and 85 miles from Teneriffe. From there the *Quest* will sail *via* St. Paul's Rocks, South Trinidad, Tristan da Cunha, and Gough Island to Cape Town, where she is due about December 1. Sir Ernest Shackleton announces that the expedition is fully equipped for deep-sea research and meteorological work, and will pay particular attention to magnetic observations. In wireless equipment the ship has two transmitting sets, one with a night range of 2000 miles, a receiving set fixed on board, two shore sets which can if necessary be used in her lifeboats, and a small set for the seaplane. A slight change in plans is announced; after returning from the Weddell Sea *via* South Georgia and Bouvet Island the *Quest* will visit Cape Town a second time before leaving for the Marion and Heard Islands and the Pacific.

THE number of ordinary scientific meetings of the Chemical Society to be held during the coming year has been increased with the object of affording greater facilities for papers to be read before the society. The first meeting will be held at Burlington House on Thursday, October 6, at 8 p.m. Following the custom of the last few years, the council has again arranged for the delivery during the session of three special lectures which, by the courtesy of the council of the Institution of Mechanical Engineers, will be held in the lecture-hall of that institution (Storey's Gate, S.W.1). The first, entitled "The Genesis of Ores," will be delivered by Prof. J. W. Gregory on Thursday, December 8, at 8 p.m. On February 9th, 1922, Sir Ernest Rutherford will lecture on "Artificial Disintegration of Elements"; while the last lecture, by Dr. H. H. Dale, entitled "Chemical and Physiological Properties," will be held on June 8, 1922.

THE Scientific and Technical Group (of members) of the Royal Photographic Society has just issued the third quarterly number of "Photographic Abstracts." It contains nearly 300 classified abstracts of publications concerning photography from practical and theoretical points of view, besides descriptions of the published results of those whose pleasure or duty it is to investigate the innumerable scientific problems connected with photography and its applications to the various branches of science and industry. There is also a classified list of about ninety recently issued patents, which deal chiefly with details of mechanism, given in title only, with full information as to the country of origin, the date and the official number, and finally an index of authors' names. Practically speaking, the journal is a descriptive index of the progress of photography in all its various aspects and applications, and it should meet with a wide appreciation, not only by photographers, but also by students, scientific investigators, photographic manufacturers, and those engaged in any industry in which photography is utilised. Those who conduct the journal merit hearty congratulations that they have in the third number brought it to such a pitch of perfection.

THE Department of Scientific and Industrial Research announces that the MS. copy of the "Bibliography of Lubricants" compiled by the Lubricants and Lubrication Inquiry Committee, referred to in the Report of the Committee of the Privy Council for 1919–20 (Cmd. 905), has been placed in the library of the Department at 16–18 Old Queen Street, Westminster, S.W.1, and is available for reference. Owing to the expense which would be involved, it is not possible to print this bibliography as originally intended. The bibliography contains in a classified form references to every paper on lubricants and lubrication which was considered by the Committee as being of definite importance. It is divided into two main parts, the papers being classified according to authors and subjects. The references themselves are divided into two sections, one dealing with the chemical, the other with the engineering and physical aspects of the subject.

FREE public lectures are to be delivered at the Horniman Museum, Forest Hill, S.E., each at 3.30 o'clock, as follow:—On October 8, "The Life and Habits of Mason Bees," F. Balfour-Browne; on October 15, "The Egyptian Pyramids," Miss M. A. Murray; on October 22, "Dredging for Marine Animals," H. N. Milligan; on October 29, "The Folk-lore of Seafaring Men," E. Lovett; on November 5, "A Naturalist on the African Lakes," Dr. W. A. Cunnington; on November 12, "Insect Collecting and its Value," F. Balfour-Browne; on November 19, "The Dawn of History in Egypt," Miss M. A. Murray; on November 26, "The Natural History of Dogs," H. N. Milligan; on December 3, "Exploring on Lake Mœris (Lower Egypt)," Dr. W. A. Cunnington; and on December 10, "Folk-lore Records from Italy, France, and Belgium," E. Lovett.

THE annual meeting of the American Metric Association will be held at Toronto on December 29 next.

The objects of the meeting are to bring together public officials, engineers, business men, and others who are interested in securing for the United States and Canada the benefits of the general use of the metric system and to utilise the information thus gained in guiding the metric movement. So far as possible the papers to be presented will outline the steps which would be necessary to make the suggested change in industry and the law. The Britten-Ladd Metric Bill now before the United States Congress will be among the subjects discussed. Suggestions and queries should be sent to the American Metric Association, 156 Fifth Avenue, New York City.

THE following committee has been appointed by the Medical Research Council, in consultation with the Ministry of Health, for the investigation of the causes of dental decay:—Prof. W. D. Halliburton (chairman), Mr. N. G. Bennett, Mr. L. Colebrook, Dr. J. M. Hamill, Sir Arthur Keith, Mrs. E. Mellanby, Mr. J. H. Mummery, and Mr. C. J. Thomas. Dr. J. M. Hamill is the secretary of the committee.

A CONVERSAZIONE of the Royal Microscopical Society will be held at the Mortimer Halls, Mortimer Street, London, W.1, on Wednesday, October 5, from 7.30 to 10.30 p.m.

THE Harveian oration of the Royal College of Physicians of London is to be delivered at 4 o'clock on Tuesday, October 18, by Dr. H. Spencer.

ONE modern school of anthropologists explains the origin of civilisation as starting from Egypt. It is therefore important to investigate how far this dissemination of culture can be recognised in Africa itself. At the Edinburgh meeting of the British Association the question was considered in a paper on "Egyptian Influence on African Death Rites," by Mr. T. F. McIlwraith. He found, particularly on the Guinea coast and in the Congo Valley, cases of desiccation of the corpse, delayed interment without the use of preservatives, burial in coffins decorated with anthropomorphic figures, and statues intended to house the soul or to serve as effigies on the grave. The fact remains that these analogies to Egyptian culture are found in West and Central Africa, not in the nearer regions of the east and south. This, he suggested, could be explained by seafarers from Egypt founding a centre on the Congo coast, whence elements of Egyptian civilisation penetrated inland or by overland influences, which had been wiped out by later intrusions of pastoral peoples.

IN connection with Mr. A. E. Harris's letter on *Ceratium furca* (NATURE, September 8, p. 42), suggesting that this organism may be moving inland, Mr. J. W. Williams, of Bewdley, Worcester, writes to say that he and Mr. H. Weaver have found the curious organ-pipe diatom *Bacillaria paradoxa*, Gmel., in abundance in the Staffordshire and Worcestershire Canal at Stourport and in Wilden Pool; Mr. Weaver has also found the organism in Charlton Pool and Hartlebury. Mr. Harris states that for a number of years *Bacillaria paradoxa* has been recognised as a constituent of the fresh-water algæ of the dykes and drains of the north-east and east of England, although its normal habitat is in salt or brackish water. That it has been found in districts hitherto unexplored is not necessarily proof that it is actually advancing inland.

SOME interesting observations on two British mammals form the subject of notes in the *Irish Naturalist* for September. Mr. A. W. Stelfox records his observations on a curious flight made one evening in July by a hairy-armed bat (*Nyctalus Leisleri*). The bat made an upward and zigzag flight into the air and continued its ascent until out of sight. Mr. C. B. Moffat, commenting on this note, states that he has witnessed similar ascending zigzag flights on the part of the same species of bat on three occasions, and is of opinion that the animal, which, by reason of its early and short period of flight, must live on day-flying insects, hopes by its ascending flight to find clearer air and a more abundant supply of insects. In the second note Mr. A. Sheals supplies evidence to show that squirrels, contrary to prevailing belief, bring forth their young quite early in the year. Mr. Moffat endorses Mr. Sheal's opinion in a commentative note, and remarks that there is reason to believe that the young squirrels born about midsummer or later are second broods.

MR. R. I. POCOCK writes on otters in the September issue of *Conquest*. His article is prefaced by a general consideration of amphibious mammals, with special reference to those characters acquired independently by species, wholly unrelated to each other, which have adopted the amphibious habit, such as the quality of the fur, the strengthening of the "whiskers" of the upper lip, and a general form of body so built as to offer the least possible resistance to water. Dealing specially with otters, the author notes their world-wide distribution and uniformity in character, due to their habit of entering the sea to fish and their ability to travel along the waterways of the world. Mr. Pocock throughout the article brings out in an interesting manner the correlation of structure with habit. Some otters, like the African otter, have given up aquatic life, and, in consequence, the bristles on the upper lip have lost much of their stiffness and the webs on the feet are reduced in size. The true sea or fur-bearing otter is of special interest in this connection. Compared with fresh-water otters it has a shorter tail, smaller and more delicate fore-paws, and very large flipper-like hind-paws. This is correlated with a general habit of swimming mainly with its hind limbs and the absence of any need for rapid movement through the sea on account of its independence of swift-swimming fishes as food. It feeds mainly on mussels and other shell-fish, crabs, and sea-urchins. The article concludes with a consideration of the affinities of otters. Mr. Pocock supports the generally accepted view that otters are related to the martens, and may be described with considerable truth as aquatic, fish-eating martens.

AN illustrated account of the trials of the motor tanker *Conde de Churruca* appears in the *Engineer* for September 16. This vessel was constructed by

Sir W. G. Armstrong, Whitworth and Co., Ltd., and has twin screws driven by Armstrong-Sulzer Diesel engines. These engines are the largest engines of the type which have, up to the present, been fitted in a British mercantile vessel. The vessel has been constructed on the Isherwood longitudinal system, and is 370 ft. long; the gross tonnage is 4550, and the mean draught is 24 ft. 3 in. with 6500 tons dead-weight on board; under these conditions the speed is 11½ knots. Each engine has four cylinders, 600 mm. bore and 900 mm. stroke, and develops 1250 brake-horse-power at 100 revs. per min. During the trials the fuel consumption of the main engines was 0·421 lb. per brake-horse-power per hour. The pistons are cooled by the Sulzer spray system, in which a spray of sea-water plays inside the piston and is discharged against its inner walls. The system works under atmospheric pressure with an open discharge, so that the engineer can gauge the temperature of each piston and cylinder unit.

A PARTNERSHIP is announced between Sir Charles Bright, Mr. A. Hugh Seabrook (late chief engineer and general manager to the St. Marylebone, London, and other electric supply undertakings), Mr. A. J. Stubbs (late Assistant Engineer-in-Chief, H.M. Post Office), and Lt.-Col. H. W. Woodall (director and consulting engineer of gas and water companies) under the style of Sir Charles Bright and Partners, consulting engineers, with offices at 146 Bishopsgate, E.C.2. The establishment of this firm is of scientific interest on account of the unusual combination of experts represented by it, which marks a development of the co-operation of gas and electricity. In addition to advising upon the installation and operation of telegraphs, telephones, and wireless and electrical undertakings generally, the firm may be consulted upon gas, water, and colliery engineering. In view of the heavy cost of fuel, economies have to be studied to-day that were negligible before the war. The firm is specialising in fuel conservation in relation to the design and construction of power plants—steam, gas, electric, hydro-electric, and oil—and particular attention is being devoted to the utilisation of low-grade fuels and carbonaceous materials hitherto regarded as waste products.

Our Astronomical Column.

CONJUNCTION OF VENUS AND MARS.—Mr. W. F. Denning writes:—"A very interesting and close approach of Venus and Mars may be well observed in the morning sky of October 3 if the weather is clear. The time of conjunction is at about 11 a.m., when the two planets will be separated by a space of a little more than a third of a degree.

"The best time to observe the event will be at about 4 or 5 a.m., as the sun rises a few minutes after 6 a.m. Venus will appear by far the more brilliant orb of the pair, and its strong silvery light will make the red aspect of Mars feeble and insignificant. This occasion will afford a good opportunity to make comparative observations of this sort, but neither of the planets will be shining at its best; in fact, Mars will be at so great a distance from the earth that its brightness will scarcely exceed that of a second magnitude star.

"The two planets will be situated in the constellation Leo, and about 10° east of Regulus, the most conspicuous star in that constellation."

OBSERVATIONS OF STAR COLOURS.—The Vatican Observatory has just published four volumes dealing with observations of star colours on Schmidt's numerical scale (modified by Osthoff). Three of the volumes are separate catalogues, based respectively on the observations of Benedetto Sestini, S.J., at Rome (1844–46), with revision by J. G. Hagen, S.J., of Friedrich Krüger at Aarhus, and of Heinrich Osthoff at Cologne. The fourth is an index catalogue, combining the results of the first three, and adding the Harvard magnitudes and spectral types. The colours, on the whole, follow the spectral types fairly closely; there is, however, a physiological effect, discussed by H. Osthoff, according to which a bright star is estimated as whiter than a faint star of the same tint; he investigated this by observing bright stars with sectors of various angles over the object glass, and found that it averaged 0·3 colour-unit per magnitude. Owing to this effect, the photographic determination of colour-index has advantages over the optical method.

The following are the adopted colour-numbers for some bright stars:—Aldebaran, 6·3; Capella, 3·3; Betelgeuse, 6·5; Procyon, 2·7; Pollux, 4·4; Arcturus, 4·7; Vega, 1·3; Altair, 2·4. It is only among the faint stars of type M*b* that numbers approaching 9 or 10 are found.

THE MOTION OF THE PERIHELION OF MERCURY.—This question is now of special interest owing to the close agreement between the value of 43″ per century given by Newcomb and the value 42·89″ deduced from Einstein's theory. Newcomb estimated the probable error of his determination as 2″ per century; but an article by E. Grossmann in *Astr. Nach.*, No. 5115, re-examines the observational evidence, reaching the conclusion that the actual range of uncertainty is much greater. Newcomb based his result partly on meridian observations and partly on transits across the sun. The difficulties in observations of the latter phenomena are well known, consisting partly in the "Black Drop," and partly in the unsteady image which the sun's heat often produces. There is the further fact that the transits all take place at two particular points in the orbit, and consequently are incapable of determining the motion of the perihelion by themselves; they merely lead to an equation between different secular motions. The meridian observations are also not very satisfactory. They lead in the mean to a distance of Mercury from the sun 2″ greater than that corresponding with its period of revolution. Moreover, Herr Grossmann shows that the observations before and after 1850 (about the time when chronographic observation began) have large systematic differences. He finally obtains 29″ and 38″ as the limiting values of the secular motion indicated by the observations. It should, however, be added that a recent series of observations made with the travelling-wire micrometer of the Cape Transit-Circle gave a value very close to that of Newcomb. It may be pointed out that the quantity actually observable is the product of the motion of perihelion by the eccentricity, which amounts to only 8″ per century.

Geography at the British Association.

THE proceedings of Section E (Geography) opened with a paper by Lt.-Col. E. F. W. Lees on Aeronautical Maps. The rapid progress in aviation has necessitated the provision of special maps for airmen. The subject was considered by the International Convention for the Regulation of Aerial Navigation of October, 1919, at which some thirty States were represented. It was agreed that there shall be two series of international aeronautical maps: general aeronautical maps on Mercator's projection on a scale of 3 cm. to 1 degree of longitude on the equator, and local aeronautical maps on a scale of 1 : 200,000. For the local maps no particular projection is laid down—in many countries maps on this scale which could be adapted for the needs of airmen already exist. Col. Lees fully described the British proposals, and explained that the divergences of view with the French and Belgian authorities as regards depiction of relief on the general maps, and some other points, have now been adjusted. The maps for the British Empire are now being constructed for the Air Ministry by the Geographical Section of the General Staff. Sir Charles Close criticised adversely the employment of Mercator's projection for the general maps. After the presidential address by Dr. D. G. Hogarth on the application of geography (NATURE, Sept. 22, p. 120), Miss A. M. B. Gillett read a paper on the historical geography of the black earth region of Central Russia. In the afternoon Capt. L. V. S. Blacker lectured on his travels in Turkistan and Khorasan from 1918 to 1920.

The meetings on September 9 opened with a joint discussion with Section L on the origin of the Scottish people, opened by Sir A. Keith, followed by a joint discussion opened by Mr. G. G. Chisholm on the teaching of geography. This discussion, while directing attention to the weakness in geographical teaching in the higher forms of secondary schools, emphasised the need for specially trained teachers in the subject.

The morning of September 12 was devoted to a number of papers dealing with the geography of Edinburgh and district. Mr. F. C. Mears showed in a series of lantern slides how the medieval period of Edinburgh was a time of town-planning and civic organisation of industry and agriculture. The town in those days was laid out on a spacious plan, with a large market place on the top of the ridge. It was no exaggeration to say that Edinburgh was a garden city until the middle of the eighteenth century. Prof. P. Geddes said that the beauty of Edinburgh to-day was largely a survival, and that we were living amid the wreckage of a noble town. In no town were the natural beauties greater, but in no town had they been more completely overlooked and thrown away. He cited the complexity of the railways in Edinburgh as an outstanding example of muddle. New developments in the search for new industries threatened the town. Edinburgh might have its new industries and greater prosperity and at the same time conserve the beauties of its site if the industrial community were more cognisant of the development and evolution of the city, and understood its geographical setting and historical past. Mr. H. R. G. Inglis spoke of prehistoric Edinburgh, and described a collection of early plans of Edinburgh, lent by the Royal Scottish Geographical Society.

In a short note communicated by Mr. G. G. Chisholm, Mr. C. B. Fawcett directed attention to the great discrepancies which exist between the real population of many large urban areas and the census populations of the chief towns in those areas. In very few towns is the city boundary thrown far enough out to include all the urban population, while in many cases the existence of densely peopled urban areas is ignored in the census return by distribution among several administrative areas.

On the morning of September 13 Dr. Marion Newbigin opened the session with a paper on the Mediterranean city-state in Dalmatia. She pointed out that the early growth of independent or quasi-independent city-states was one of the most characteristic features of the Mediterranean area, a fact which suggested that such cities were a response to the geographical conditions. By an analysis of these conditions it was shown that they rendered possible local aggregations of population supported by intensive cultivation of the peculiar Mediterranean crops, and that further, the nature of these crops permitted the cultivators to dwell together in a walled town, placed on a site suitable for defence. The advantages and disadvantages of such sites were considered, especially the factors which limited growth in size. In Dalmatia, as elsewhere, the sites first chosen were not, as a rule, such as to facilitate either land or sea trade, but the limiting factors rendered it necessary that some supplement to the natural products should be found if the city were to attain any size. The significance of the sea-borne trade between the Mediterranean area and the Far East in promoting the prosperity of certain Mediterranean cities was pointed out. The lecturer then dealt more particularly with Dalmatian towns. Finally the constant recurrence of piracy, from Roman times onwards, on the Dalmatian shore was emphasised alike in connection with the medieval cities and with Italian policy to-day.

Lt.-Col. H. S. Winterbotham gave an account of the present position of the 1 : 1,000,000 map. The effect of the war on the progress of the map was curiously mixed. In some countries considerable progress was made, in others large areas were mapped on the desired scale, but not in strict conformity with the international resolutions, while in many cases the work was brought to a standstill. The provisional series of the 1 : 1,000,000 map covering most of Europe and the Near East, for which the Royal Geographical Society and the Geographical Section of the General Staff were responsible, reached 89 sheets in close, if not complete, conformity with the international scheme. Of the international map, properly speaking, only 28 sheets are published, and 132 are in course of preparation. In Europe France, Italy, Denmark, Norway, Sweden, and Britain are each at work on several of their respective sheets. In India eight sheets have appeared, and several others are in hand. Japan and Siam are also at work. In Africa sheets are in hand of the Belgian Congo, Egypt, the Sudan, and South Africa. The United States has practically all its sheets in hand, and Canada has made a beginning. In South America great blocks in Brazil, Chile, and the Argentine are under way. Nothing has been done in Australia. Lt.-Col. Winterbotham concluded by showing that maps on 1 : 1,000,000 scale exist for many other areas but not in the international style.

Miss R. M. Fleming read a paper on the geographic aspects of tradition. The share of physical and social environment in moulding tradition is easy to trace. For instance, the beauty of the Hebrew traditions was no doubt partly due to a leisurely life of wandering in vast spaces, and a familiarity with quiet solitudes. From the fact that they express the accumulated experience of past generations, an out-

come of the hard conditions in which they grew, these traditions have been appreciated by the rest of the world. In studying stories of the origin of death one sees how the essential theme varies widely according to environment and experience. In certain instances Miss Fleming traced the adaptation to particular environments of a central theme. Lastly she showed how tradition grew and lingered around early trade routes.

The morning of September 13 closed with a paper by Mr. H. M. Spink on the distribution of commercial timber on the Pacific Coast of North America. In the afternoon Mr. A. W. Grabham lectured on his recent experiences in a journey from Lake Tana to Roseires, paying special regard to the water supply. The work of Section E included visits to Leith docks and the cartographical works of Messrs. J. Bartholomew and Co., and Messrs. W. and A. K. Johnston.

An Automatic Recorder of Smoke Pollution.

IN an article on "London Air" in the *Times* of August 23 Sir Napier Shaw directed attention to the clear atmosphere which was such a noticeable feature in all industrial centres during the recent coal strike. The article in question is, however, chiefly interesting for its description of an ingenious self-recording contrivance invented by Dr. J. S. Owens for the Atmospheric Pollution Committee of the Meteorological Office, which registers hourly the amount of solid atmospheric impurities. A fixed volume of air is aspirated through a small disc of filter-paper, and from the depth of shade the amount of deposit is estimated by comparison with discs of standard shades. In London the notably dirty period is from 9 a.m. to 5 p.m., *i.e.* the business hours of the day. The greatest impurity is, of course, in winter, that of a May day being about one-quarter that of a November day. The day impurity in May is of the same order as the night impurity in November. The instrument should prove useful in detecting any noticeable improvement or otherwise in the amount of solid impurities in different towns. Although Sir Napier Shaw states that these measurements of the Committee "are noteworthy as the first series of systematic observations of the pollution of the air of London and other centres of population," he has apparently overlooked the fact that a complete series of records was made in Leeds some years previously, in the course of which it was clearly established not only that the domestic fireplace is responsible for much the larger proportion of the soot emitted from burning coal, but also, more important still, that this domestic soot is much more highly contaminated with tar than that from factory chimneys. In his reference to possible means of smoke prevention from domestic fireplaces, Sir Napier Shaw makes no reference to the carefully considered report which was published in the autumn of last year by the Committee on Smoke Abatement appointed by the Ministry of Health. It was there pointed out that the ordinary open kitchen range was wasteful and inefficient, and the Committee strongly insisted on the advantage of gas-cookers where gas was available. Low-temperature coke was also advocated whenever the right sort of material could be placed upon the market—a desideratum not yet attained. But there are numerous forms of improved ranges in which coke and anthracite can be burned much more economically than in the old open range, and, of course, without the emission of smoke. It now remains for the Ministry of Health to bring pressure to bear on those engaged upon Government building schemes to adopt these recommendations. It has a unique opportunity for setting an example in atmospheric purification.

University and Educational Intelligence.

BELFAST.—Dr. J. K. Charlesworth has been appointed professor of geology in the Queen's University. Until the present session the head of the department of geology was a lecturer, but, owing to the importance of the subject, the Senate has raised the lectureship to a professorship.

BIRMINGHAM.—The University has now been in existence for twenty-one years, and in commemoration of the event the Council and Senate have invited a large number of friends of the University to a conversazione on October 7, at which the Edgbaston buildings will be open to inspection.

LONDON.—Mr. A. E. Webb has been appointed senior assistant in the department of civil and mechanical engineering of University College. Mr. C. D. Burns has been appointed lecturer in philosophy at Birkbeck College.

In connection with the department of philosophy of King's College a course of ten public lectures will be given by Prof. H. Wildon Carr on "The Modern Scientific Revolution and its Meaning for Philosophy" on Tuesdays at 5.30, beginning on October 11. In connection with the faculty of psychology a similar number of lectures on "Psychology and Psychotherapy" will be given by Dr. W. Brown on Tuesdays at 5.30 beginning on October 18.

ST. ANDREWS.—Dr. W. J. TULLOCH, lecturer in bacteriology in the University, has been appointed to be the first professor of the chair of bacteriology, established and approved by his Majesty in Council on June 27 last.

THE Salters' Institute of Industrial Chemistry has awarded fellowships for post-graduate study in the laboratories of the institute to Messrs. J. A. Gentle, F. Raymond Jones, S. J. Saint, and F. W. Turner. Scholarships have been awarded to Messrs. B. G. Banks and L. G. Laws.

POST-GRADUATE research scholarships in naval architecture of 250*l.* a year each have been awarded by the Institution of Naval Architects to Mr. H. W. Nicholls, of the Royal Naval College, Greenwich, who will carry out research on the vibration of ships, and Mr. W. R. Andrew, of Liverpool University, who will investigate the behaviour of ships at sea during a long-distance voyage, and report on shipbuilding and conditions abroad.

SOME bequests of noteworthy importance are made in the will of Mrs. L. A. Stuart, widow of Prof. James Stuart. Cambridge University Local Lecture Syndicate will receive a sum of 5000*l.* for a James Stuart endowment in memory of Prof. Stuart's work in founding the University Extension Lectures. In addition, Trinity College, Cambridge, is to receive 2000*l.*, which it is suggested should be applied to the establishment of Stuart scholarships or studentships, and a similar sum is bequeathed to Newnham College, Cambridge.

ON Tuesday, October 11, a dinner in honour of Prof. J. C. Philip will be held in the Imperial College Union, Prince Consort Road, South Kensington, at 7 for 7.30 p.m., when Sir William A. Tilden will present to him an illuminated address and gifts from his colleagues and students to express deep appreciation of Prof. Philip's active interest in every movement for the advancement of the Royal College of Science during his service, now twenty-one years, on the chemical staff of the college. The chair will be taken by Sir Richard Gregory, president of the Royal College of Science Association.

Calendar of Scientific Pioneers.

September 29, 1839. Friedrich Mohs died.—Trained at Halle and the Mining Academy, Freiburg, in 1817 Mohs succeeded Werner in the chair of mineralogy at the latter institution. He was afterwards attached to the Imperial Academy of Vienna. His most important work was his "Grundriss der Mineralogie."

September 30, 1870. William Allen Miller died.—Appointed in 1845 to follow Daniell as professor of chemistry at King's College, London, Miller the same year made some of the earliest researches on the spectra of glowing gases—researches which in 1862 led to his pioneering work with Huggins in the spectra of the heavenly bodies.

October 1, 1768. Robert Simson died.—A devoted student of the Greek geometers, Simson for fifty years held the chair of mathematics at Glasgow. His edition of "The Elements of Euclid," published in 1756, was the basis of nearly all editions for more than a century.

October 1, 1895. Ernst von Rebeur-Paschwitz died.—As a *privat docent* at Halle and an assistant at Karlsruhe Observatory, Rebeur-Paschwitz, in spite of ill-health, made important observations in seismology and improved Zöllner's instruments. He died at the age of thirty-four.

October 2, 1848. Georg August Goldfuss died.—Called to Bonn from Erlangen as professor of zoology and mineralogy, Goldfuss held a high place among German mineralogists. With Münster he published the "Petrefacta Germaniæ," an uncompleted monumental work designed to illustrate the invertebrate fossils of Germany.

October 2, 1853. François Jean Dominique Arago died.—Rendered famous at an early age by his adventures when engaged on geodetical operations in Spain, Arago became one of the best-known men of science of his day. He made important discoveries in optics and electro-magnetism, zealously advocated the undulatory theory of light, and studied the physical properties of steam and other gases. With Gay Lussac he started the *Annales de Chimie et de Physique*, in 1830 became director of the Paris Observatory, and as permanent secretary to the Paris Academy of Sciences wrote many notable *éloges*. He was also one of the first successful popularisers of science and a politician.

October 2, 1901. Karl Rudolf König died.—A native of Germany, König settled in Paris as an instrument-maker, and afterwards gained a reputation for his excellent workmanship and for his numerous inquiries and experiments in acoustics.

October 2, 1905. Dewitt Bristol Brace died.—After studying at the Johns Hopkins and Berlin Universities, Brace about 1886 became professor of physics at Nebraska. He especially studied the action of the magnetic field upon light, and was also known for his refined experiments on the æther drift.

October 5, 1880. William Lassell died.—Lassell, while engaged in business as a brewer, constructed a Newtonian reflector, with which in 1847 he discovered a satellite to Neptune. In 1848 he discovered Hyperion, a satellite of Saturn, and in 1851 Ariel and Umbriel, satellites of Uranus.

October 5, 1912. Lewis Boss died.—After serving as astronomer to the United States Northern Boundary Commission, Boss became director of the Dudley Observatory, Albany, N.Y. Especially known for his work on proper motions and star catalogues and on the orbits of comets, in 1905 he was awarded the gold medal of the Royal Astronomical Society.

E. C. S.

Societies and Academies.

PARIS.

Academy of Sciences, September 12.—M. Léon Guignard in the chair.—R. **Serville**: The conical pendulum as affected by a screen.—L. **Dunoyer**: The induction spectrum of rubidium. The metal was distilled in a vacuum into a quartz tube and the latter placed in the field of a high-frequency alternating current. The tube is luminous even at the ordinary temperature, and is a bright violet-blue at 100° C. At 200° C. the colour changes to lilac. With an exposure of twenty minutes as many as 332 lines were photographed; the arc spectrum of rubidium contains about 30 lines, and the spark spectrum about 60. A list of the wave-lengths is given, of which only two appear in the arc or flame spectra.—R. **de Mallemann**: The inversion of the rotatory power of derivatives of tartaric acid.—Q. **Majorana**: The absorption of gravitation.—M. **Stuart-Mentiath**: Granitised outcrops of the border of the Pyrenees.—E. F. **Terroine** and R. **Wurmser**: The influence of temperature on the utilisation of glucose in the development of *Aspergillus niger*.

Books Received.

Aluminium and its Alloys: Their Properties, Thermal Treatment, and Industrial Application. By Lt.-Col. C. Grard. Translated by C. M. Phillips and H. W. L. Phillips. Pp. xxiii+184+17 plates. (London: Constable and Co., Ltd.) 17*s*. 6*d*. net

Life of Elie Metchnikoff, 1845–1916. By Olga Metchnikoff. (Authorised translation from the French.) Pp. xxiii+297. (London: Constable and Co., Ltd.) 21*s*. net.

Survey of India. Professional Paper, No. 18: A Criticism of Mr. R. D. Oldham's Memoir, "The Structure of the Himalayas and of the Gangetic Plain, as Elucidated by Geodetic Observations in India." By Lt.-Col. H. McC. Cowie. Pp. ii+33. (Dehra Dun: Trigonometrical Survey.) 3*s*.

Memoirs of the Geological Survey: Scotland. Description of Arthur's Seat Volcano. By Dr. B. N. Peach. Pp. 26. (London: E. Stanford, Ltd.; Southampton: Ordnance Survey Office.) 2*s*. 6*d*. net.

A Text-book of Aeronautical Engineering: The Problem of Flight. By Prof. H. Chatley. 3rd edition, revised. Pp. xii+150. (London: C. Griffin and Co., Ltd.) 15*s*. net.

Handbuch der biologischen Arbeitsmethoden. Edited by Prof. Dr. Emil Abderhalden. Abt. 10, Methoden der Geologie, Mineralogie, Paläobiologie, Geographie. Heft 1, Lieferung 28. Pp. 128. 21 marks. Heft 2, Lieferung 35. Pp. 129–312. 30 marks. Abt. 9, Methoden zur Erforschung der Leistungen des tierischen Organismus. Teil 1, Heft 1, Lieferung 34: Allgemeine Methoden. Pp. 96. 30 marks. Abt. 5, Methoden zum Studium der Funktionen der einzelnen Organe des tierischen Organismus. Teil 7, Heft 1, Lieferung 12: Sinnesorgane. Pp. 195. (Berlin und Wien: Urban und Schwarzenberg.)

Fisheries—England and Wales. Ministry of Agriculture and Fisheries. Fishery Investigations: Series 1: Freshwater Fisheries and Miscellaneous. Vol. 2, No. 1: The Methods of Fish Canning in England. Pp. 25. (London: H.M. Stationery Office.) 2*s*. 6*d*. net.

Annals of the South African Museum. Vol. 18, part 3, 5: The Odonata or Dragonflies of South Africa. By F. Ris. Pp. 245–452+plates 5–12. (London: Adlard and Son and West Newman, Ltd.) 30*s*.

Flora of the Presidency of Madras. By J. S. Gamble. Part 4: *Rubiaceae* to *Ebenaceae*. Pp. 579–768. (London: Adlard and Son and West Newman, Ltd.) 10*s*. net.

Entropy as a Tangible Conception: An Elementary Treatise on the Physical Aspects of Heat, Entropy, and Thermal Inertia, for Designers, Students, and Engineers, and particularly for Users of Steam and Steam Charts. By Eng. Lieut.-Comdr. S. G. Wheeler. Pp. 76. (London: Crosby Lockwood and Son.) 8*s*. 6*d*. net.

Mikromethodik: Quantitative Bestimmung der Harn- und Blutbestaudteile in kleinen Mengen, für klinische und experimentelle Zwecke. By Dr. L. Pincussen. Pp. 116. (Leipzig: G. Thieme.) 28 marks.

Department of Applied Statistics (Computing Section), University of London, University College. Tracts for Computers, No. 5: Table of the Coefficients of Everett's Central-Difference Interpolation Formula. By A. J. Thompson. Pp. xvi+20. (London: Cambridge University Press.) 3*s*. 9*d*. net.

Nia Cintaga Pano kaj la Vivo. Serio de tridek doktrinoj pri dieto subtenitaj de kelkaj el la plej famaj homoj. Kompilita kaj Tradukita de W. W. Trainer. Dua Eldono. Pp. 71. (Glasgow: Fraser, Asher and Co., Ltd.; Author: 329 Langside Road, Glasgow.) S.250.

The Stages of Human Life. By J. Lionel Tayler. Pp. xiv+377. (London: J. Murray.) 18*s*. net.

The Heart of Nature; or, The Quest for Natural Beauty. By Sir Francis Younghusband. Pp. xxviii+235. (London: J. Murray.) 12*s*. net.

Columns: A Treatise on the Strength and Design of Compression Members. By Dr. E. H. Salmon. (Oxford Technical Publications.) Pp. xvi+279. (London: H. Frowde and Hodder and Stoughton.) 31*s*. 6*d*. net.

An Introduction to Physics for Technical Students. By P. J. Haler and A. H. Stuart. Pp. 240. (London: Library Press, Ltd.) 4*s*. 6*d*. net.

Ministry of Munitions and Department of Scientific and Industrial Research. Technical Records of Explosives, 1915–18, No. 3: Sulphuric Acid Concentration. Pp. vi+91. (London: H.M. Stationery Office.) 12*s*. net.

The Wit of the Wild. By Ernest Ingersoll. Pp. v+212. (London: G. Routledge and Sons, Ltd.) 6*s*. net.

The Care of the Adolescent Girl: A Book for Teachers, Parents, and Guardians. By Dr. Phyllis Blanchard. Pp. xxi+201. (London: Kegan Paul and Co., Ltd.) 7*s*. 6*d*. net.

Taboo and Genetics: A Study of the Biological, Sociological, and Psychological Foundation of the Family. By Dr. M. M. Knight, Dr. Iva L. Peters, and Dr. Phyllis Blanchard. Pp. xv+255. (London: Kegan Paul and Co., Ltd.; New York: Moffat, Yard and Co.) 10*s*. 6*d*. net.

Seven Ages of Childhood. By Ella L. Cabot. Pp. xxxiv+321. (London: Kegan Paul and Co., Ltd.) 12*s*. 6*d*. net.

Diary of Societies.

MONDAY, OCTOBER 3.

SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—G. O. Case: The Winning of Tidal Lands in British Guiana.

WEDNESDAY, OCTOBER 5.

ROYAL MICROSCOPICAL SOCIETY (in the Mortimer Halls, Mortimer Street, W.1), at 7.30.—Conversazione.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

CHEMICAL INDUSTRY CLUB (at 2 Whitehall Court).—Sir William J. Pope: Impressions of Canadian Tour.

THURSDAY, OCTOBER 6.

CERAMIC SOCIETY (Refractory Materials Section) (at Institution of Mechanical Engineers), at 10.30 a.m.—H. Dewey: Refractory Materials of the London Basin.—J. H. Marlow: The Marlow Gas-fired Tunnel Oven.—P. J. Woolf: A New Type of Tunnel Kiln, Oil-fired, with many Novel Features.—Dr. A. Granger: Aluminothermic Corundum as Refractory Materials.—Prof. J. W. Cobb and H. S. Houldsworth: The Reversible Thermal Expansion of Silica.—Discussion on Gas-firing.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Air-Commodore H. R. H. Brooke-Popham: Some Notes on Aeroplanes in Tropical Countries.

CHEMICAL SOCIETY, at 8.—S. J. Lewis and F. M. Wood: A New Adjustable Thermostat for all Temperatures between 0° and 100°.—A. F. Dufton: The Separation of Miscible Liquids by Distillation. Laboratory Still-heads.—A. F. Dufton: The Separation of Miscible Liquids by Distillation. A Continuous Laboratory Still.—P. K. Dutt, H. R. Whitehead, and A. Wormall: The Action of Diazo-salts on Aromatic Sulphonamides. Part I.—A. B. Manning: Neutral Salt Action on the Hydrolysis of Ethyl Formate.—A. Shimomura and J. B. Cohen: Synthetic Optical Activity.—T. A. Henry and H. Paget: Chenopodium Oil.—C. K. Ingold and E. A. Perren: Experiments on the Synthesis of the Polyacetic Acids of Methane. An Addendum to Parts I. and III.—C. K. Ingold and W. J. Powell: Experiments on the Synthesis of the Polyacetic Acids of Methane. Part IV. The Preparation of β-carboxymethanetriacetic Acid.—The Late H. R. Le Sueur and C. C. Wood: The Mechanism of the Action of Fused Alkalis. Part II. Action of Fused Potassium Hydroxide on Phenylglyceric Acid.

FRIDAY, OCTOBER 7.

CERAMIC SOCIETY (Refractory Materials Section) (at Institution of Mechanical Engineers), at 10 a.m.—General Meeting.

WEST LONDON MEDICO-CHIRURGICAL SOCIETY (at West London Hospital), at 8.30.—Sir G. Lenthal Cheatle: A Study of Breast Cancer in Relation to the Cancer Problem (Presidential Address).

CONTENTS.

	PAGE
The Explosion at the Nitrogen Fixation Works, Oppau	137
Applied Chemistry	138
Institution and Behaviour in Fijian Society. By W. J. Perry	139
Laboratory Designs. By Chas. E. Browne	140
The History of Anatomical Illustration. By Dr. Charles Singer	141
Our Bookshelf	142
Letters to the Editor:—	
Scientific Publication.—Dr. F. A. Bather, F.R.S.; J. A. H.	144
Is Bisexuality in Animals a Function of Motion?—Dr. J. H. Orton	145
The Separation of Mercury into Isotopes. — Prof. William D. Harkins and R. S. Mulliken	146
Relation of the Hydrogen-ion Concentration of the Soil to Plant Distribution —Norman M. Comber	146
The "Proletarisation of Science" in Russia.—Dr. H. Lyster Jameson	147
Bees and Scarlet-runner Beans.—H. B. Heywood	147
The Norman Lockyer Observatory. (*Illustrated.*) By Prof. H. H. Turner, F.R.S.	148
The Oxford Expedition to Spitsbergen, 1921: Ornithological Observations. (*Illustrated.*) By The Rev. F. C. R. Jourdain	151
The Present Position of the Theory of Descent, in Relation to the Early History of Plants. By Dr. D. H. Scott, F.R.S.	153
The Shackleton-Rowett Oceanographic and Antarctic Expedition. By Dr. Hugh Robert Mill	159
Obituary:—	
Dr. Walter George Ridewood. By C. W. A.	160
Notes	160
Our Astronomical Column:—	
Conjunction of Venus and Mars	164
Observations of Star Colours	164
The Motion of the Perihelion of Mercury	164
Geography at the British Association	165
An Automatic Recorder of Smoke Pollution	166
University and Educational Intelligence	166
Calendar of Scientific Pioneers	167
Societies and Academies	167
Books Received	167
Diary of Societies	168
(INDEX.)	

THURSDAY, OCTOBER 6, 1921.

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The Prevention of Venereal Disease.

THE interest of many readers of NATURE has no doubt been aroused by recent correspondence in the *Times* upon the subject of prevention of venereal disease, together with the trenchant article by its medical correspondent directing attention to the refusal by the Ministry of Health to accede "to the application of some of the greatest medical authorities in the world for leave under Section 2 of the V.D. Act of 1917 for":—

"The preparation and sale by chemists under the supervision and control of the Society for the Prevention of Venereal Disease of the materials for immediate self-disinfection recommended by them,"

And for:—

"The framing and issue by the Society for the Prevention of Venereal Disease of the necessary instruction for the efficient application of those disinfectants, as it is obvious that the provision of disinfectants without instructions as to their application would greatly diminish the efficacy of this method of prevention of venereal disease."

Owing to the very serious immediate and remote results upon the health of the nation of this widespread preventable disease, which has increased in prevalence as a result of the war, it is desirable to consider the facts concerning the measures which the Ministry of Health have adopted or prepared, and compare the same with those in operation in the Commonwealth of Pennsylvania.

The Ministry of Health has established 191 free treatment centres, which cost last year half a million pounds. The taxpayer will naturally ask whether people who incur the risk should not be required to pay for treatment, and it is not surprising, therefore, to find indications of a change of policy of the Ministry, for on page 119 of the recently-issued Report of the Chief Medical Officer it is stated:—

"It is extremely desirable that fuller arrangements should be made by the authorities for bringing the general practitioner within their schemes of treatment or education. It cannot be too clearly understood that the best way of dealing with most cases of these diseases is through the skilful private practitioner. For a substantial portion of this problem, the public clinic should be looked upon as a temporary organisation pending the time when the practitioner is ready, available, competent and properly equipped to undertake effective treatment. Certain patients require hospital treatment, but the authority should not needlessly establish institutions, if and when the ordinary channels of medical practice are available and reliable or can be made so."

This pious medical opinion should be compared with the following practical measures which have been adopted and carried out by the Health Commissioner of the Commonwealth of Pennsylvania.

"The Department of Health of the State of Pennsylvania maintains thirty public clinics for the treatment of venereal disease, over which it has entire supervision and for which it assumes all financial responsibility. In these clinics free treatment is given to those patients whose economic condition will not permit treatment either by private physicians, or by clinics charging a fee. Upon entrance to clinics, patients are questioned as to their ability to pay for services. Those able to pay a private physician are referred to outside doctors who are registered with the clinics. If in a position to pay only a small sum they are referred to hospital clinics which charge a nominal fee. Indigent patients are treated in the State Clinics."

It will be observed that discrimination is shown in respect to free treatment. The practitioner registered with the clinic, it may be assumed, is ready and capable of carrying out treatment efficiently, for which he is paid by the infected person.

In our system there are no measures taken to prevent discontinuance of treatment, consequently a large percentage remain infective and are left to spread the disease broadcast. This is manifested by the table of statistics in the Report, which shows that of 176,415 who attended the 183 treatment centres in the year 1919–20, 59,328 did not complete the course of treatment, 15,831

discontinued before final tests regarding cure were completed, and only 21,540 were discharged after completion of treatment and observation.

The health authority of Pennsylvania has foreseen this important matter of discontinuance of treatment, and it has enacted the following regulations :—

"When a patient discontinues treatment before he (or she) is cured or rendered non-infectious, the social service worker follows up the case and sees that the patient returns to the clinic as long as the disease is in the infective state. This is accomplished first by sending him a notice to return for treatment. If this does not effect a return, the clinic makes use of the legal machinery at the disposal of the Department of Health.

"Venereally diseased patients in the infective stage are subject to quarantine, when through neglect of treatment, habits, occupation or failure to protect others, they are menaces to the public health."

In this country there are no legal measures of this nature, and the very large percentage of persons attending the clinics who discontinue treatment and disregard the warning they receive, or should receive, that they are still infective and a menace to society, shows that some further measures of a disciplinary nature are necessary to make these clinics efficient.

The following passage from the Report of the Ministry of Health indicates that a number of the clinics are not efficient.

"I am bound to advise that if the work of these clinics is not properly done—if it is casual, superficial or perfunctory—they should be disapproved by the Ministry. It is better to have only a few clinics well organised and scientifically controlled than a large number which are not thus administered."

The small percentage of persons attending the clinics who were discharged as certainly non-infectious, and the large percentage who do not complete a cure and are still infective, is explained if the service at a number of these clinics is casual, superficial, and perfunctory.

We entirely agree with the Report in the statement :—

"Whilst the V.D. clinic has proved in practice the centre of the treatment, it is but part of the national scheme for dealing with these diseases. The other and more important part concerns prevention."

But how does the Ministry propose to carry it out? By ablution treatment at the clinics. But the Report shows dissatisfaction with the service at a number of the clinics. Is it likely that ablution and irrigation will be efficiently carried out where the treatment is liable to be "casual, superficial and perfunctory"?

The Report gives the following reasons against the advocacy of the practice of self-disinfection :—

"The Ministry believe that thorough cleaning and skilful disinfection of the body immediately after risk of infection has been incurred tend substantially to reduce the likelihood of disease, but the Ministry are not prepared to recommend a general practice of self-disinfection apart from skilled advice and supervision. It is believed that except under skilled control attempts at self-disinfection are likely (1) to be ineffective; (2) to create a false security and thus an increase in promiscuity; and (3) to lead to postponement of treatment which thus becomes more difficult and uncertain. It is impracticable to train the general public in effective *self*-disinfection by means of leaflets of instruction. What is required in all such cases is not general directions for self-manipulation but prompt and skilled advice."

We may ask, is this fear of failure the sole reason? Are there not, in a great measure, the same influences at work that interfered with prophylaxis by self-disinfection being carried out efficiently in the services during the war, viz. the National Council and its supporters, which set out to combat venereal disease and still finds it increasing in spite of its moral propaganda and curative treatment centres.

We have no desire to dispute the fact that "skilled disinfection" as carried out by the American Army was efficient, but let us see what the Commissioner of Health of Pennsylvania says about skilled disinfection in civil life :—

"Immediate treatment (venereal prophylaxis) for those exposed to disease has been approved by the Pennsylvania State Department of Health. Prophylaxis as used in the army by means of stations is impracticable in civilian life. Tubes containing material for self-disinfection are given the Department's approval, when after tests they meet requirements. The material usually employed is after the formula of Metchnikoff. The tubes are on sale in drug stores."

Any unprejudiced thinking person must see many grave defects in trusting to disinfection stations to control venereal diseases effectively, even if municipal authorities change their mind and sanction the increased expenditure which such stations would entail.

It is certain that a large proportion of civilians who expose themselves to infection could not, or would not, seek skilled disinfection even if the locality of the stations were favourable and even if its efficiency were all that could be desired.

The delay in a majority of cases would prevent skilled disinfection from being effective. From an economic and efficiency point of view, therefore, we are of opinion that the Health Department of Pennsylvania has wisely adopted "self-disinfection" as one means of controlling venereal disease, and it is to be regretted that the offer of the Society for Prevention of Venereal Disease, backed by the names of so many distinguished physicians and surgeons, should have met with a curt refusal from the Ministry of Health.

L'Espace dans la Chimie.

The Principles of the Phase Theory. Heterogeneous Equilibria between Salts and their Aqueous Solutions. By Dr. Douglas A. Clibbens. Pp. xx+382. (London: Macmillan and Co., Ltd., 1920.) 25*s.* net.

AMONG the gifts which the older science of physical chemistry gave to chemists, undoubtedly the graphical treatment of heterogeneous equilibria, founded on the phase law of Gibbs, will always occupy a prominent position. Begun and extensively developed by Roozeboom and van't Hoff, this most valuable and elegant branch of science has been carried on in a masterly fashion by Schreinemakers. Special and most important developments of it are due also to Cohen and to Smits.

So great and conspicuous is the work of these five Dutch physical chemists that we may fairly call the science of heterogeneous equilibria a Dutch science. This statement is all the more justified when we recollect that the theoretical and experimental physics of the simpler systems is very largely due to the work of the Dutch physicists, van der Waals, Kamerlingh Onnes, Kuenen, Keesom, and Crommelin, etc. The Dutch nation is indeed to be congratulated on the splendid work which their men of science have done in this field, and it is pleasant to observe that Dr. Clibbens has dedicated the present volume to Prof. Schreinemakers.

The great power of the graphical treatment of heterogeneous equilibria lies in its ignoration of co-ordinates. In order to apply it we do not require to know the co-ordinates which define the *inner mechanism* of equilibrium in any phase. It is not even necessary that the constituents of any phase should be in perfect inner equilibrium. All that is necessary is that the various phases should be in equilibrium with each other—that is to say, that the chemical potential of each component should have the same value in all the phases, and that the same thing should hold good for temperature and hydrostatic pressure (at least in all ordinary applications).

We may say that what cartography is to the geographer and land traveller, practical astronomy to the navigator, and engineering drawing and graphics to the engineer, the graphics of heterogeneous equilibria is to the chemist. Without the maps made by other chemists and the knowledge of how to do his own surveying and map-making, the chemist of to-day will do much useless wandering, and probably lose his way entirely.

It is a strange thing that, even after the lapse of some thirty years, so little real attention is devoted to the science of heterogeneous equilibria in our instructional courses in chemistry at the universities and higher technical schools. The only people who take it seriously are the metallurgists. From their closer connection with the outside world they know that it spells business, and very good business too; but in reality it is just as important for the chemist. Whatever chemical work he does in the world, he will have at some stage or other to separate heterogeneous mixtures into pure constituents by crystallisation, distillation, sublimation, and phase-distribution. In designing chemical processes and plant he will be asked by the engineer to specify what phases will be present and in what amounts, under specified conditions of pressure, temperature, and concentrations of initial materials. The engineer, accustomed to quantitative data and calculations, will want the answer in figures. He does not want any of the "tricky" work of Mary Ann making the Sunday rice pudding, although that is just what he gets at present from the majority of chemists—even highly trained ones, who can tell you what the inside of an atom looks like, or what the camphor molecule would be like if it would keep quiet and stand at attention. These learned gentlemen resemble an engineer who has "jumped" all his engineering drawing and graphical statics, and taken to the study of relativity. Even the members of the "Argonaut" expedition had some sort of map in their great quest.

No man can really claim to be a well-trained chemist nowadays unless he can handle the theory and practice of a four-component system as he would an ABC railway-guide. Alas, how many of us can say that? We mean well, but when it comes to the test we fall back on the methods of Mary Ann. Every university chemical institute should have a special laboratory and a special drawing-office for the study of heterogeneous equilibria. The reason for this is

not pride, or romance, or vainglory, but simply the sober necessities of business. And what young man is there with soul so base that the beautiful geometry of this work would not appeal to him and be a more than sufficient compensation for the tribulations arising from the analytical work? The mind of the chemist, unlike that of his future colleague the engineer, really dwells in a point. He lacks the sense of space and the power of thinking spatially, or, rather, most of his work tends to produce that lack. What better corrective could there be than the study of a four-component system? If the chemist is going to rule the world—as he hopes and as he ought—he must cease to be a point-man. He must become an understander and controller of space. If not, well, then the engineer will occupy the space, and the poor old chemist will continue to sit at his point and wonder what is wrong—as he has done these many years.

In the preface to his book Dr. Clibbens gratefully and gracefully expresses his indebtedness to Capt. Francis Arthur Freeth, under whom he studied the science of phase-equilibria in the research department of Messrs. Brunner, Mond, and Co. There is also an introduction by Capt. Freeth. No doubt Dr. Clibbens would be the first person to admit that this book is really a product of the Brunner, Mond Research Laboratory, and therefore of its director, Capt. Freeth. During the past fourteen years the science of heterogeneous equilibria and its practical application have reached a degree of development by Capt. Freeth, which is unequalled in any part of the world. Known to very few before the war, this fact became revealed to many by the magnificent work which Messrs. Brunner, Mond, and Co. did in connection with the manufacture of ammonium nitrate by three different methods. It is an open secret now that the work which this company did in this field alone saved the cause of the Allies at a critical stage. The final method which they employed—namely, the direct production of ammonium nitrate from sodium nitrate and ammonium sulphate, was a splendid triumph of scientific industry. Success was due to the intimate co-operation of scientifically trained directors and engineers with the Chemical Research Department; but the former would be the first to admit that, without the exact data yielded by Capt. Freeth's series of phase-isotherms, no successful process—indeed no process at all—could have resulted.

There have been many books dealing with heterogeneous equilibria, from the pioneer text-books of Bancroft and van't Hoff to those of Findlay and Kremann. Foremost amongst the more fundamental treatises stands, of course, the great work of Roozeboom, ably continued by Schreinemakers, with which may be classed the "Gesättigte Lösungen" of Jänecke, and the "Ozeanische Salzablagerungen" of van't Hoff. The present work of Dr. Clibbens is the first book in English to attack seriously the real geometry of the subject. He carries us from the delightful simplicity of binary systems right up to the real thing—quaternary and quinary systems. It is evident that Dr. Clibbens can think in space, and expects his readers to do the same. That is certainly necessary; but if one might cavil at all it would be to suggest that the author follows Schreinemakers a little too closely in his method. In leading the novice up the steps of Parnassus Dr. Clibbens has no mercy in his geometrical logic. As the mind of the ordinary man—and especially that of the chemist—gets abstract only by gentle degrees, it would have been well if the author had paused, at each stage in his heavenward journey, to work out *thoroughly*, both geometrically and arithmetically, a typical concrete case; and in his admiration for triangular co-ordinates he fails to do justice to the less general but very useful system of open rectangular co-ordinates.

But these are small matters in comparison with the great value and excellence of the book. It is one which every chemist must study and digest, and it is certain that it will have a great and salutary effect on the rising generation of English-reading chemists. Messrs. Brunner, Mond, and Co. are to be heartily congratulated on the important contribution which their research department has made to the advance of chemical science.

To the young chemist of the present day one may say these words. Study the mighty atom and its still mightier inside. Study also the organic molecule with its trailing field of glory and its vibration-frequencies; but if you want to be a man amongst men in the great world that toils with large masses do not "jump" the geometry of heterogeneous equilibria. It is the key that unlocks many doors.

Practical Anti-tuberculosis Work.

Industrial Colonies and Village Settlements for the Consumptive. By Sir German Woodhead and P. C. Varrier-Jones. With preface by Sir Clifford Allbutt. Pp. xi+151. (Cambridge: At the University Press, 1920.) 10*s.* 6*d.* net.

NO one wishing to be prepared adequately for practical anti-tuberculosis work can afford to neglect this little volume. Its authors

are well known for their protracted studies of the subject, which are embodied in the present volume. We could have wished that the different essays and addresses, which form the larger part of the book, had been rewritten in more regular sequence, for this would have saved the reader's time and conduced to more impressive exposition. However, the whole of the work deserves study, and there is something to be said in favour of repetition of the same theme from a new angle.

There cannot be said to be anything exactly new in the book, except in the important particular that what others had discussed and regarded as desirable, in the Cambridgeshire colony described in this book, has been shown to be practicable and competent to bring improved results in the treatment of tuberculosis. There is, with the possible exception of syphilis, no disease which better illustrates than tuberculosis the synthesis and inseparability of treatment and prevention. Each patient treated successfully is thereby deprived of the power of infecting others; and each patient who, apart from cure, is taught during treatment the hygiene of his disease, and made to believe practically that his own recovery, as well as the safety of others, depends on his adopting hygienic precautions in coughing and expectorating, is an added influence towards the extermination of tuberculosis. There is appositeness in the illustration, that just as Sir Arthur Pearson said to his blind pupils: "The first thing you have to do is to learn to be blind," so the consumptive must "learn to be a consumptive," and to play the game both for himself and for those about him. It is because so many sanatoria have failed to impress this lesson, and to make it part of the life of the consumptive, that the loafing habit has been encouraged, and even partial return to industrial efficiency has been exceptional.

Others before the present authors have advocated farm colonies, industrial colonies, after-care associations, and allied agencies, and much good work has been done. At the Bourn and Papworth colonies a demonstration has been made of the practicability of dealing with all classes of consumptives at one institution. This practical application of the *vue toute ensemble* is especially valuable, particularly so when the views adopted by the authors of this book on the pathology of tuberculosis and the essential measures for its prevention are those which offer the greatest prospect of success. We all know that the infection of tuberculosis cannot be entirely avoided, but that practical danger arises only when the dosage of infection surpasses the powers of resistance. Hence minimisation of infection and measures for improving general health must go hand in hand.

The authors speak with authority on the importance of preventing the spread of massive infection, of "turning off the tap before we begin to empty the trough." Again: "Small doses of tuberculous virus *may* be harmless, large doses *must* be guarded against." They quote Sir Arthur Newsholme's conclusion that the admission of a large proportion of advanced consumptives to infirmaries has lessened the spread of disease, and add that this "points the way to the next step—the segregation of these middle cases in colonies, where, with the best chance possible of recovery, they also cease to be a source of infection to others." It is on this principle that the Cambridgeshire Tuberculosis Colony is based. It is an all-round scheme, covering every grade of tuberculosis: "We are satisfied that it is impossible to keep tuberculous patients in watertight compartments," and therefore early, middle, and advanced cases are treated in separate divisions of the same institution, which comprises the hospital at one end of the scale, the village settlement at the other, with intermediate rest houses for febrile patients, open-air shelters, hostels, and workshops. Here the patient has a reasonable hope of being made, not into a valetudinarian, but into a useful and productive member of society, who, although he may remain a consumptive, can even enjoy his life.

This is a hopeful view of the problem. Such institutions have a definite and increasing possibility of utility. It would, of course, be a mistake to assume that colonies of this kind cover the whole problem. They could not do so unless they were adopted on a gigantic scale; for various reasons a large number of chronic, but incurable, consumptives will need to be dealt with in urban homes, in hospitals, and in their own homes. A large proportion of partially recovered patients will recover only 75, 50, or 25 per cent. of their full working capacity, and there is need for the further organisation, on a scale commensurate with the magnitude of the problem, of provision for them of the three desiderata which are quoted by the authors of this book from an official report in the following words: "If the patient is to have the best possible prospect of recovery, and if his family are to be safeguarded against infection, in many cases he will need (*a*) improved housing; (*b*) occupation adapted to his physical capacity, etc.; (*c*) the family income will need to be supplemented. These requirements

for many patients have not hitherto been met."

The last section of the volume is an admirable summary of the subject. We hope it will be read by, and give fresh heart to, all engaged in national tuberculosis work. We wish it could be brought home also to the hearts and minds of central and local governing bodies, who, unfortunately, at the present time, are engaged in whittling down essential public health activities, which is anything but economy of the welfare of the Commonwealth, on which efficiency depends.

Physics and Chemistry of Bioluminescence.

The Nature of Animal Light. By Prof. E. N. Harvey. (Monographs on Experimental Biology.) Pp. x+182. (Philadelphia and London: J. B. Lippincott Co., 1920.) 10*s.* 6*d.* net.

BIOLUMINESCENCE—that is, the production of light by animals and plants—is a phenomenon which has excited wonder in the layman and given rise to many investigations on the part of the man of science. Since the results of these investigations, many of them of a purely qualitative nature, are widely scattered in the literature of various countries and not always readily accessible, the author has rendered a distinct service in collating the various facts and presenting them to the scientific public as a connected whole. The biological aspect is referred to but briefly, in a chapter on the structure of the luminous organs, the main portion of the book dealing with the physical characteristics of animal light and the chemical processes underlying its production. The study of bioluminescence is another instance of the application of physics and chemistry to biological and physiological problems; the author's treatment is clear and, so far as the present state of our knowledge is concerned, convincing; it shows, moreover, that he has full command of the cognate sciences.

After providing, in the first two chapters, an account of the physical phenomena of luminescence and incandescence, in which, especially, the various kinds of luminescence are adequately discussed; a detailed description is given of the results obtained in the physical investigations of the nature of animal light. It is in such physical investigations that most progress of a definite nature seems to have been made. Exact quantitative measurements have established that the light emitted is in no way different from ordinary light, except in intensity and spectral extent; it is all visible light, containing no infra-red or ultra-violet radiations or rays which are capable of penetrating opaque objects. Like ordinary light, it will cause fluorescence and phosphorescence of substances, affect a photographic plate, cause marked heliotropism of seedlings, and stimulate the formation of chlorophyll.

The efficiency (=visible radiation × visual sensibility÷total radiation) of the firefly as an illuminant seems to be of the order of 96 per cent.—that is, immeasurably superior to any artificial source of light. The light, however, supposing it could be put to use, would not be suitable for artificial illumination, since all objects would appear a nearly uniform green hue. Although the light of the firefly is the most efficient known, so far as amount of light for expenditure of energy is concerned, it has been produced at the inevitable expense of range of colour.

The last three chapters deal with the chemistry of light production and the dynamics of luminescence. As is only to be expected from the nature of the case, the chemistry of bioluminescence has not yet been placed on a basis as satisfactory as the physics thereof; the evidence, as yet, is mainly of a qualitative nature. It seems to be established that, in at least three groups of animals, luminescence is due to the interaction of two substances, luciferin and luciferase, in the presence of water and oxygen. Luciferase is a protein, all its properties agreeing with those of the albumins, and may be regarded as an enzyme; luciferin has many properties in common with the proteoses and peptones, but its chemical nature still remains to be decided. The stage to which our knowledge of the dynamics of animal luminescence has advanced may be indicated by the fact that the author only commits himself to the statement that "perhaps the reaction takes place in two stages," a compound luciferin–luciferase being first formed and then undergoing oxidation.

A valuable bibliography is given at the end of the book, which is printed in clear type and well supplied with illustrations and diagrams.

T. S. P.

Our Bookshelf.

The Arithmetic of the Decimal System. By Dr. J. Cusack. Pp. xvi+492. (With answers.) (London: Macmillan and Co., Ltd., 1920.) 6*s.*

DR. CUSACK is a firm believer in the decimal system, and there can be no doubt that he speaks with some authority, in view of the great experience he has enjoyed of teaching arithmetic and other branches of a business training to all classes of pupils. Many have argued theoretically about the educational and commercial advantages of a

decimal system, as against the complicated notations now in use in this country, and some have worked out decimal systems which they considered suitable for introduction by Act of Parliament. Dr. Cusack has gone a step further by producing a text-book of arithmetic in which the calculations are all in terms of the decimal notation, and the various quantities dealt with, like length, area, volume, weight, and money, are all decimalised.

The author does not desire to introduce the *metric* system. This is merely one form of decimal system, and Dr. Cusack considers that we in this country are so much accustomed to the use of the yard, the hundredweight, the gallon, the pound sterling, etc., that it is necessary to retain these units in any decimal system we employ. The effect of the acceptance of this idea would therefore be merely the abolition of the vulgar fraction in business and other calculations; the difference between the English and the Continental units would still remain. This is not the place for a discussion of the problem, but it must be pointed out that a considerable fraction of the advantages derivable from such a radical change of our English system of units would be lost if we refused to fall in with the Continental metre, gramme, and litre. As regards money units, the matter is entirely different—international exchanges have such huge relative time-gradients that it is idle to attempt any international equalisation of the currency.

Dr. Cusack's book is excellently written and produced. It is really a piece of propaganda literature, and as such it should have more effect than any number of Parliamentary speeches and Chamber of Commerce resolutions in educating public opinion in the direction of accepting a long-overdue reform of our system of units.

S. BRODETSKY.

Annales de l'Observatoire astronomique de Tokyo. Tome 5, 4e fascicule. Studies on Astronomical Time-Keepers and Time-Preserving Systems. By Kiyofusa Sôtome. Pp. ii + 59. (Tokyo: Imperial University, 1921.)

THE problem of the determination and distribution of accurate time has been advanced considerably in recent years by the use of the moving wire in observing transits, and the introduction of wireless time-signals. Hence the analysis of the behaviour of high-class time-keepers under various conditions, which is dealt with in this memoir, is likely to be of general utility. Mr. Sôtome notes that chronometers are essential in Japanese observatories as a supplement to pendulum clocks, on account of the prevalence of earthquake shocks, which produce abrupt changes on the error and rate of a clock, but have no sensible effect on a chronometer. It is shown that the chronometer rates are sensitive to changes of atmospheric pressure and humidity, so that an air-tight case should be used. Most of the chronometers showed perceptible change of rate according to the interval that had elapsed since winding; this change was diminished by using a falling weight instead of a spring as motive power, a method that is practicable in an observatory, but not at sea.

The section on pendulum clocks deals not only with those at Tokyo, but also with the records of the standard clocks of several European observatories. There is a curious general tendency to acceleration of rate, which may be due to accumulation of dust, rust, etc., on the rod and bob. An examination is made of the properties of different metals that are used as pendulum rods; it is found that invar is subject to gradual elongation and irreversible thermal expansion; quartz or tungsten are suggested as suitable. The importance of an air-tight chamber, with constant pressure and temperature, is emphasised.

Finally, the memoir deals with the determination of true time, which involves the distribution of error between the transit observation and the timepiece. It is suggested that abnormalities in the former may sometimes be due to lateral refraction, arising from unsymmetrical temperature distribution. The ratio of probable errors of the observed transit and the assumed clock rate having been found by experience at each observatory, formulæ are given for obtaining a weighted mean clock error.

A. C. D. CROMMELIN.

String Figures. By W. W. Rouse Ball. Second edition. Pp. 69. (Cambridge: W. Heffer and Sons, Ltd., 1921.) 2*s.* 6*d.* net.

THIS book is a second and enlarged edition, of which we have already noticed the first issue (NATURE, vol. 106, p. 640). The subject is comparatively new, though one variety, the cat's cradle, has a literary pedigree from the eighteenth century, and the boys at Christ's Hospital used to play it in the time of Charles Lamb, as related by that charming writer in his essay on the famous foundation; but the discovery of the more interesting forms dates from the Cambridge expedition to Torres Straits in 1898 under the leadership of Drs. Haddon and Rivers. Since then many interesting figures have been recorded, notably in America, by Mrs. Jayne.

The invention is certainly due to the lower culture, and the distribution of the figures is very interesting. That known as "Lightning" comes from the Navaho Indians of Arizona; the now almost extinct Apaches passed on the "Tent Flap" to the Mexican Indians; "Man Climbing a Tree" comes from the Queensland blacks; the "Batoka Gorge" was accidentally discovered by someone who showed some other figures to the native police escort at the Victoria Falls. In fact, as Mr. Ball tells us, no self-respecting anthropologist ought to go about without a piece of string in his pocket. As anyone can now learn a fascinating game under his careful guidance, it may be hoped that field anthropologists will soon tell us more about its various methods and its origin.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Resting-place of Robert Boyle.

SOME months ago, having become very much interested in the life and work of the famous English philosopher, the Hon. Robert Boyle, and animated to a certain extent by the spirit of the pilgrim, I thought I would go and look at his last resting-place. According to Thomas Birch, who brought out in five folio volumes the works of Boyle with a "Life" in the year 1744, the philosopher died on December 30, 1691, seven days after his sister Katherine, Lady Ranelagh, with whom he had been keeping house in Pall Mall for more than twenty years. Brother and sister were buried in the chancel of St. Martin's-in-the-Fields.

On reaching the church I learned that the old church in which they had been laid was pulled down in 1721 and replaced by the present edifice. On inquiry of the rector he referred me to his churchwarden, Mr. John MacMaster, from whom and from his interesting book on the church the following facts are derived:—

The foundation-stone of the new church was laid by the Bishop of Salisbury on March 19, 1721. James Gibbs, a pupil of Wren's, was the architect. "As the bodies buried in the church and part of the churchyard would be disturbed during the rebuilding, an advertisement was inserted in the newspapers notifying that the bodies and monuments of any of those buried could be taken away for reinterment by relatives on application to the Vicar, Wardens, and Commissioners. Several bodies and monuments were removed." It appears, however, that applications for permission to set up family monuments in the same position in the new church as in the old were not granted, and those monuments from the old church which were not taken away by relatives were stored under the tabernacle or, in some cases, set up in the vaults and crypt of the present church. It is on record that "Robert Boyle, the gifted son of the Earl of Burlington," was among those buried in the church, but no systematic account was kept of the disposal of the remains in the old church, and there is no monument bearing the name of Boyle in the crypt at the present day.

As it seemed possible that there might be some tradition in the family of action taken by them in 1721 to preserve the remains of the philosopher, I wrote to the present Earl of Cork and Orrery, but could get no information. Later, Lady Grace Baring (*née* Boyle) informed me that after looking into books of family records in her possession no clue could be found to the mystery of Robert Boyle.

It is remarkable that Birch's account of the funeral and burial should have been published without comment or correction in 1744, or more than twenty years after the destruction of the old church. No modern biographer seems to have inquired further into the matter, and it seems probable that the last resting-place of the "Father of Chemistry" will remain unknown to the end of time.

WILLIAM A. TILDEN.

September.

Biological Terminology.

DR. BATHER (NATURE, August 18, p. 778) wishes me to explain my glaring truism, "Variation is the sole cause of non-inheritance: apart from variations, like exactly begets like when parent and child develop under like conditions" [of nurture]. But does it need explaining? As he says, and as I have insisted, variation *is* non-inheritance, and for that reason the truism is glaring. The words "the sole cause of" are really redundant, and were introduced merely to emphasise the fact that there is no other cause. My justification for framing the truism lies in the fact that that truth is more honoured in breach than in observance in biological discussions. I have already expressed myself much in the following terms, but some repetition seems necessary. Every character is a product of antecedent *and* exciting cause, of nature *and* nurture, of potentiality *and* stimulus, of power to develop *and* opportunity to develop. Since the multicellular individual is derived from a germ, he can inherit only through it. In the germ are none of the characters subsequently developed in the soma, but only powers to develop them. Therefore, strictly speaking, he inherits nothing but these powers, the sum of which is his nature, while the sum of the influences which cause change (or arrest it) is his nurture. By a colloquialism, which is pardonable since it confuses no one, we speak of a child inheriting his parent's eyes, or hair, and so on. If a child in response to similar nurture produces hair like his parent's, he has not varied in this respect; he has inherited; he is like his parent both by nature and through nurture. If he develops different hair in response to similar nurture, he has varied; to that extent he has not inherited. If owing merely to different nurture (*e.g.* injury) he produces different hair, or even none at all, he has *inherited*, but not *reproduced*.

Inheritance is altogether an affair of nature; reproduction implies the added element of nurture. Reproduction is proof of inheritance; but non-reproduction is not proof of non-inheritance. There is, indeed, massive evidence of inheritance without reproduction—*e.g.* in latent ancestral traits, male characters in the summer generation of aphides, and the recessive in the impure dominant. If for "hair" we substitute in the foregoing *any* of the characters which biologists call "acquired," and use our words with the same meanings, then all I have said remains exactly true. For example, if a parent and child receive similar injuries and develop similar scars, then the child *inherits* the scar. He would really have inherited even if he had not received the injury and developed the scar. But biologists no not give their words with the same meanings. If a child produces an "acquired character" in the same way as the parent did (if he is like the parent both by nature and through nurture), they say he has not inherited, but acquired, that trait afresh—as if every trait were not acquired afresh every time. They assume that he would "inherit" only if he reproduced the same trait in response to some different nurture, only if he did not inherit, only if he were unlike the parent both by nature and through nurture. The word "inherit" now means "vary." Now comes my point. The truism is founded on the assumption that all characters that can possibly be developed are, *necessarily*, and in exactly the same sense, equally innate, acquired, germinal, somatic, and inheritable. Nearly all biological discussions (*e.g.* the Neo-Lamarckian and Neo-Darwinian) are based on contrary assumptions, and imply, therefore, the denial of the truism. If it were accepted *and borne in mind*, most of the labours and disputes

which have occupied biologists would automatically end, and the way be cleared for further advance. Is this the explanation that Dr. Bather desires?

Can Dr. Bather tell us in terms of utility why, when all characters are equally innate, acquired, and inheritable, biologists should distinguish them from one another by these terms? I am sure he will find the task impossible. Fortunately, the historical explanation is clear. Formerly it was universally believed (and still is popularly) that the soma of the child was derived, by means of physiological units, gemmules, or what not, from that of the parent—the child's head from the parent's head, and so on. Granting that assumption, this, the child's heritage, was innate. But it could be altered, as by injury and use, and these alterations were acquired. If the soma of the child took origin in that of the parent, it was reasonable to believe that characters acquired by the parent could be transmitted in some degree to the child in whom they would be innate. Hence the Lamarckian hypothesis. Obviously, with this conception of heredity, the application of the distinguishing terms "innate," "acquired," and "inheritable" was intelligible and correct. Characters actually were innate *or* acquired, inheritable *or* non-inheritable. Nature and nurture were warring forces, and attempts to estimate their relative strength were reasonable. But no clear distinction could be drawn, and, in fact, none was drawn, between variations and modifications, which were all called variations. The truism was not true, for what we now recognise as modifications altered the heritage, and like did not produce like under like conditions of nurture alone.

After the discovery of the cellular structure of the body the belief grew that the heritage travelled solely down the germ-tract. If that were true, only potentialities to develop in this or that way were transmissible; all characters were equally products of nature and nurture; the terms "innate," "acquired," and "inheritable" became inapplicable to characters as distinguishing terms; the physiological classification of characters as responses to various stimuli became necessary and clear, as did also the distinction between variations and modifications; nature and nurture were not warring, but co-operating, forces; the Lamarckian discussion became absurd, for valid reasoning cannot be founded on non-existent differences; the truism became true, and, since it covered almost the whole area under discussion, there ensued a vast simplification of study. One now thought of development in terms of nurture, and evolution and heredity in terms of the potentialities of the germ-plasm, which was conceived as changing through the ages, by the accumulation of variations in it, in such ways that some of the old potentialities were eliminated or altered and some new ones evolved. For example, one conceived man as differing from the oak because his nature, and therefore his nurture, was different. One ceased to regard him as a being compounded of innate and acquired characters.

Biologists failed to perceive fully the necessary implications of their own discoveries. "Men believe that their reason rules over words; but it is also the case that words react, and in their turn also use their influence on the intellect." The words "innate," "acquired," and "inherit," sanctified in usage by tradition, exercised a fatal influence. Instead of perceiving that all characters are equally innate, acquired, and inheritable, biologists proceeded to fortify the error by coining new synonyms ("germinal," "somatic," "blastogenic," and the like) and to discuss the "transmission of acquired characters," "the intensity of inheritance," and so on. In other words, the old notion that the parts of the child are derived from those of the parent was wonderfully combined, by means of a misuse of language, with the new and quite incompatible belief that the heritage travels down the germ-tract. When a supposition is true or untrue it may be proved or disproved. When it is nonsensical it can be neither proved nor disproved. Crucial testing is then impossible; discussion leads merely to more nonsense. At once the word "inherit" acquired, quite unnoticed, two contrary meanings, and, besides, was often used as synonymous with "reproduce." Endless controversy arose; sects developed; holy ways of gathering (*i.e.* restricting) evidence were acclaimed; the habit of calmly examining all the evidence by means of crucial testing fell very largely into abeyance. Thus did biology achieve the scientific status of theology and politics. Hence the present chaos. Hence the fact that, though biologists believe that all characters that develop in response to use are "acquired," they, following tradition, limit the term to some only of the characters that so develop. For example, while they term the muscles of the blacksmith "acquired," they consider those of the child and the ordinary man, which grow in response to similar nurture, "innate." Hence the failure to observe the magnitude of use-developments in the higher animals, and, therefore, to perceive what is for human beings the most important phase of all evolution, that of the power of so developing. Hence the fact that I, a mere outsider, neither zoologist nor botanist, am able to write so impudently without fear of being eaten like a shrimp, as would have happened had I assailed physics, chemistry, mathematics, astronomy, or descriptive zoology or botany.

Biologists may declare that their terms have technical meanings. But no such meanings which accord with usage can be thought of. The evidence in literature is plain that every writer has really believed that some characters are more innate, acquired, and inheritable than others. Witness the synonyms. Again, biologists may declare that when they discuss Lamarckian "inheritance" they merely consider whether these so-called acquirements so alter the germ-plasm (cause it to vary) that a character, which evolution fitted ancestors to develop in response to use or injury, tends to be developed by descendants in some other way—*e.g.* in response to a hormone. But why not use plain and correct language? Why designate characters which are not especially innate, acquired, and inheritable by those terms? Why say "inherit" when exactly the opposite (vary, non-inherit) is meant? Why suppose that characters which develop in response to use or injury (and only some of these) have this amazing property of causing such wonderful germinal alterations? Why not speculate as to whether the development in ancestors of ordinary muscles in response to use tends so to change the germ-plasm that ordinary muscles can be developed in descendants in response to other influences—*e.g.* hormones? Why not question whether the development of hair and teeth in ancestors in response to hormones tends to cause their development in descendants in response to other influences—*e.g.* use or injury? Use, injury, hormones, and the rest of what we call nurture are all influences to which evolution has made the individuals of the different races responsive; why, then, select only two of them as causes of "acquirements" in progenitors and of "innate" characters in descendants? Why ignore the evidence furnished by the evolution of the higher animals, which demonstrates that, so far from "innate" characters replacing in decendants characters acquired by ancestors, the contrary has happened on a vast scale; for, unlike low animals, the higher types (in proportion as they are

high in the scale) are born helpless, and must develop mentally and physically in response to use before they can reach maturity and power of maintaining independent existence.

Dr. Bather writes with an air of surprise, "Actually we are now talking of biological method." But have we talked of anything else? What other is the insistence on precision of language and the necessity for crucial testing, and the discussion about the nature of evidence and proof? He continues, "My own difficulty has been to devise a question that should be universally accepted as crucial, or, having devised one, to elicit the relevant facts." He indicates the trouble exactly. Many biologists—among whom I am sure must be Dr. Bather himself—have tested their suppositions thoroughly and established them completely, and yet have had them rejected on irrelevant grounds by large sections of their fellows who have unlike ideas as to what constitutes evidence and what proof—Darwin with his theory of natural selection, for example. Some years ago the late Prof. William James, much amused, furnished me with a case in point. He had happened on an article which seemed to him, as it afterwards did to me, good and conclusive. This he submitted to a biological colleague, who, while disputing not a fact (the facts were indisputable) or an inference (I think the inferences were incontrovertible), quite simply declared that he hoped they had done with that sort of thing for ever. It seems he was a devotee of one of the exact and modern methods.

As to the "difficulty . . . to elicit the relevant facts," I, of course, know nothing about Dr. Bather's special troubles; but I do know that biologists in general have always extraordinarily restricted the area in which they have sought their facts, and that, in the search for exactitude and modernity, they have recently restricted it still further. Of course, other things being equal, "biologists who can experiment with their material are certainly in a far better position to perform both these operations than one who can only observe portions of extinct animals." But that is not the point in dispute. Many sciences deal with organisms that are not extinct; and while experiment may add, and, indeed, has greatly added, to our knowledge, it can do no more; for, after all, it is only one out of several ways of collecting evidence. Dr. Bather says: "Either the glaring truism is an identical proposition or it is a statement actually disputed." I believe he is not quite correct. The statement that "variation is the sole cause of non-inheritance" is, in effect, identical with the statement that, "apart from variations, like exactly begets like when parent and offspring develop under like conditions," *and* it is actually disputed. Moreover, the truism is practically identical with the statement that, "apart from variations, offspring tend to recapitulate the parental development." It is true that biologists are divided on this point—as they are divided on almost everything else—but only, I think, because they use the words "inherit" and "reproduce" as synonymous. I hope to deal with this matter shortly.

I assure Dr. Kidd (NATURE, September 1, p. 11) that there is no "catch" in this correspondence. I have used the plainest and simplest language I can think of, and have pleaded only for the use of ordinary scientific methods, including plain and precise language. I am too ignorant to reason about the hair-patterns of the modern horse; but of this I am sure, that if the collar altered the hair-pattern of the ancestral domestic horse, and if the modern colt reproduces this alteration without experience of the collar, then we have here not inheritance, but variation of a very remarkable and unusual sort. In that case the modern horse is like his domestic ancestor neither by nature nor by nurture. He is like only in very superficial seeming. If Dr. Kidd will not accept the blacksmith's arm as a good illustration, why not reason from that of the ordinary man, which also, as I say, develops in response to functional activity, and has so developed not for twenty, but for twenty thousands of generations.

G. ARCHDALL REID.

Southsea, September 6.

The Green Colouring of Surf on the Horizon.

ON December 16, 1920, at 5h. 30m. p.m. Central Java time, while the steamer *van Noort* was passing by the small island of Pisang, north of Kroë, on the western coast of Sumatra, at a distance of about 3 km., I noticed that the breakers on the shore were not white, but green. Observing the phenomenon with a binocular it was possible to see more details. The low breakers especially showed the green colour. Breakers rising higher became white, the lower right and left corners, however, remaining green. As the breaker ran forward along the shore a green corner preceded, and sometimes the separate crests seemed to be coloured. Along the shore of Sumatra, at a distance of 7 km., no particular colours could be observed. From the upper decks of the steamer the colour could be seen, but it was less intense.

The weather was calm, the sky partly clouded, and the sea grey. The horizon was strongly dipped; I saw a sharp horizon before the isle, the surf seeming to rise above this horizon. By no means could a continuous surface of the sea be seen between the ship and the island. The phenomenon disappeared at 6h. 10m. p.m., when the yellow shore-line of the isle had become invisible below this apparent horizon.

My object in directing the attention of readers of NATURE to this phenomenon is to learn whether the green colouring of surf has ever been observed before. I have been unable to find any description of it, and shall be very glad to learn whether the phenomenon has been seen and recorded by others.

As to the explanation, I believe the cause to be the same as that of the "green flash," as the phenomena agree remarkably in some respects.

Observations of the green flash have been published in NATURE (vols. 93, 94, and 95 of 1914–15). Mr. C. T. Whitmell writes:—"Under favourable conditions at sunset, as the upper segment of a yellow sun gradually diminishes, the right and left corners of the segment become green; this colour gradually spreads inwards, becoming marine, until finally the last tip of the sun may appear almost greenish-blue" (NATURE, March 11, 1915, vol. 95, p. 35).

The same observation has been made by Dr. C. Braak ("Hemel en Dampkring," August, 1915, p. 52).

Both phenomena seem to be caused simply by atmospheric dispersion of light, as is explained, for example, in a most valuable article by Dr. A. A. Rambaut ("The Green Flash on the Horizon," *Symons's Meteorological Magazine*, No. 41, 1906).

The green flash and the "green surf" are not very common phenomena. Dispersion being always present, one may wonder why the green colouring is rather rare. Evershed discussing this fact writes:—"It seems to me very probable that this phenomenon is in some way connected with the abnormal conditions which at sea produce mirage effects. The layer of dense air in contact with the sea might produce total reflection for solar rays refracted from below the horizon, but the critical angle of reflection will depend on wave-length, and it is possible under certain conditions that the green rays may be totally reflected, whilst the red are refracted" (NATURE, May 15, 1915, vol. 95, p. 286).

Indeed, the green flash is often accompanied by strongly deformed images of the setting or the rising sun. Dr. Braak concludes that the green flash may be observed most frequently with a strongly notched limb of the sun. The occurrence of the distinct dip of the horizon at the time of observation of the green colouring of the surf agrees fairly well with these views. S. W. VISSER.

Weltevreden Observatory, Java, August 16.

Scientific Publication.

IN NATURE of September 8, p. 41, Dr. Brierley refers to a sore point of modern scientific workers, viz. the difficulties of scientific publication, and brings forward some, to use his own expression, "revolutionary" suggestions for overcoming these difficulties. I am fully convinced that Dr. Brierley's proposal to combat this evil by abandoning the practice of publishing in full works of scientific merit, deleting technical portions, and eliminating plates, and substituting for them summaries for the convenience of the "general scientific public," would prove to be a great hindrance to scientific progress if adopted.

Dr. Brierley's arguments for the adoption of this course are: (1) that the majority of papers have no permanent value in the advancement of science, and (2) that the special articles are not intelligible to workers in other branches of the same science.

It is very difficult to judge the value of scientific publications, and still more difficult to predict their possible value in the future. Mendel's paper, for instance, at the time of its publication in 1865, escaped notice, and could be termed "of no permanent value" by his contemporaries, but, as we know, it was "discovered" about twenty years later, and proved to be the foundation of the new doctrine of heredity. The truism that all scientific works, whether great or small, are the foundation on which the building of science is constructed stands good here.

It is highly important that all works should be published in full for the benefit of specialists all over the world, and not in "popular" form for the general scientific public, which will always find what it wants in general treatises and summaries. This would be impossible if, as Dr. Brierley suggests, the original memoirs were stored "in a kind of Somerset House for scientific records." Indeed, this would take us back to the Middle Ages.

The difficulties of scientific publication, however, are real, and I think that instead of *faire bonne mine à mauvais jeu*, as Dr. Brierley suggests, we should do our utmost to save the position and apply to the State for subsidy. We can surely afford to save our scientific literature, taking into account that scientific papers published in the whole country during one year are but a fraction of what is published daily in the Press in London alone. CECIL A. HOARE.

Behaviour in Lizards.

WE kept here this summer two common lizards (*Lacerta vivipara*), one a very active male, the other a female which was much less active because she was soon to give birth to a litter of young. One day I turned a batch of earwigs into the lizards' bowl, and a vigorous hunt ensued. When a lizard seizes any sort of prey it shakes it violently and repeatedly before swallowing it, thus incidentally advertising its success. At one moment it happened that the female was worrying an earwig when the male had none. He darted across and tried to snatch her earwig from her. She eluded him that time, but a few seconds later he tried again and succeeded. She made no attempt to get the earwig back; soon after he had swallowed it, however, she pounced on him and bit his elbow, tearing off a small piece of skin.

This was remarkable enough, since at all ordinary times these lizards never showed any sign of resentment—when, for example, one of them spread itself over the other in competing for a patch of sunlight. But about two minutes later something happened which surprised me still more. The female sighted an earwig sheltering half under a stone. Seeing the quick, purposeful turn of her head, the male ran up on to the stone and stood waiting. Neither moved for some seconds; then with a dart the female seized the male by the snout and held him for two or three seconds in spite of his struggles. The moment he freed himself she pounced on the earwig (which had not moved), and went through the usual actions of worrying, champing, and swallowing without further interference from the male.

On a cold day our lizards were scarcely more lively than newts. Temperature made all the difference to them. After half an hour of hot sunshine the male was as active and alert as a terrier; he would leap at flies and catch them in the air. This episode with the earwigs happened on a hot day, but even so it seemed to imply cerebral processes which one scarcely expects to find in such an animal as this small lizard.

E. LEONARD GILL.

Hancock Museum, Barras Bridge,
Newcastle-upon-Tyne, September 28.

Breeding Periods of Newt and Slow-worm.

ON September 27, when examining a ditch-pool which used to produce Hydra, I found a number of larvæ of the common newt varying in size from 11 to 20 mm., the smaller two-legged, probably less than two weeks old, the larger more advanced, with well-grown hind-legs.

The pool in question was dried up during the early summer, and until half an inch of rain on July 15 and 16 thoroughly wetted the ditches no newts could have bred there, although they were breeding in a deep quarry-hole within a hundred yards. We regularly obtain newt larvæ in July for class purposes, but the end of September seems unduly late.

Three possible explanations suggest themselves:—(1) The old newts in the locality have bred twice, (2) the spring-born newts have bred in late summer, or (3) newts belonging to the place in question have been able to hold up their spawn until favourable conditions occurred, which did not happen until the third week in July.

It would be interesting to have the observations of other naturalists on late breeding.

Last year, when the weather conditions were very different, slow-worms were late in breeding, gravid females occurring in the last week in September and newly hatched young in the second week in October.

RICHARD ELMHIRST.

Keppel, Millport, September 29.

The Highest Inhabited House.

I SHOULD very much doubt the accuracy of the statement in NATURE of September 15, p. 78, that a dwelling at 17,100 feet in the Andes is the highest inhabited house in the world. I feel confident that this can be claimed to be the case in the Himalayas, probably in the Karakoram or Ladak chains in the

north of Kashmir, where there are several high passes between the altitude of 18,000 and 19,000 ft. Within my own personal knowledge, the highest inhabited house (at least for a few weeks in the summer of each year) is near the summit of the Donkia Pass in the north of Sikkim, which is claimed by the Tibetans to be in Tibet, the height of the pass, according to the trigonometrical survey, being 18,100, and per aneroid 18,400 ft., at which height the amount of oxygen in the air is only about half that at sea-level. This is a stone hovel, and is occupied by a Tibetan guard or outpost of four or five men. It would be an easy matter for the inhabitants of the Tibetan Plateau to become acclimatised to that altitude, living, as they do, at a height of between 15,000 and 16,000 ft. I wonder, however, whether the rarefication of the atmosphere adversely affects their longevity, as is known to be the case with the monks of St. Bernard in the Swiss Alps.

Plymouth. W. HARCOURT-BATH.

THE remark found fault with by Mr. Harcourt-Bath is not mine, but the author's (Prof. Bowman, p. 52 of his work on "The Andes of Southern Peru").

The surest way of breaking a supposed world record is to publish it.

No doubt Prof. Bowman was not aware of Mr. Harcourt-Bath's experience in Tibet, otherwise he would not have stated that "the loftiest habitation in the world is in Peru." Both may be stone hovels, oblong and grass-thatched (there is a good photograph on p. 48), and both houses happened to hold five people. But whilst the Tibetan custom-house officers seem to be on duty for only a few weeks in the height of the season, the Peruvian shepherd family appear to use their place as a permanent residence. "At frequent intervals during the three months of winter snow falls during the night and terrific hailstorms in the late afternoon drive both shepherds and flocks to the shelter of leeward slopes or steep canyon walls."

The altitude of the Great St. Bernard Hospice is only 8,100 feet, about the same, or even less, than that of several large towns in Mexico where longevity is common. The self-sacrificing Augustine monks, resident for a limited number of years, do suffer, not from the rarefied air, but from the severe and vile climate and unheated rooms. THE REVIEWER.

The Use of the Classics.

IN discussing "Classical and Modern Education" (NATURE, September 8, p. 64) is there not some clear separation needed between two very different purposes of training in the classics? For knowledge of human nature, for political sense, for the feeling of the life of past times and its views, translations are practically as effective as original texts. The gain from using the original language is that of the æsthetic values and training. To revile "the inadequacy of translations" solely refers to the æsthetic values, and not to the practical values for life. What has been the effect on Europe of translations from Hebrew and Greek in the Bible? Do we talk of exposing their inadequacy as a reason for ignoring them? Why have many great scholars worked for years at translations if they thought them useless?

The cant of the grammarian trying to sink the classics under the weight of his own interests in language must be ignored. Let us have every child in a secondary school familiar with the great authors, from Herodotus to Ammianus, and then let those who have ability and time for language learn, as we learn Hebrew, off a familiar translation. W. M. F. P.

Indian Land Mollusca.

IN Lt.-Col. Godwin-Austin's instructive review of the latest volume in the official "Fauna of India" (NATURE, September 22, p. 106) he rightly lays stress on the importance of preliminary work in the preparation of what are supposed to be authentic handbooks. May I state that on hearing that Mr. Gude's volume was in actual preparation I wrote offering the loan of the material in the Indian Museum, including both the whole of Nevill's type-specimens and the vast accumulation of unnamed material obtained by the Zoological Survey of India in recent years. My offer was ignored or refused, apparently because the volume had to be out by a given date. I make this statement because I find that it is commonly believed that the Zoological Survey of India, of which I have the honour to be director, is in some way responsible for the "Fauna of British India." This is not the case. N. ANNANDALE

Auroral Display of September 28-29.

DURING the whole night of September 28 I was photographing the spectra of stars. In the early morning, at 1.25 a.m. G.M.T., I was leaving the dome to proceed to another dome, in which Mr. W. B. Rimmer was working, when I observed a bright aurora low down on the northern horizon. I called Mr. Rimmer, and we observed it together.

The streamers, of a whitish hue, were scintillating and changing their intensities very rapidly; sometimes one streamer became very brilliant and faded away, and sometimes another. The whole phenomenon from the time I first observed it lasted about twenty-five minutes. Up to the time of writing I have seen no published record of this aurora.

WILLIAM J. S. LOCKYER.

Norman Lockyer Observatory, Salcombe Hill, Sidmouth, South Devon, October 2.

The Isotopy of the Radio-elements.

THE nucleus-model of the radio-elements proposed by Lise Meitner (*Die Naturwissenschaften*, vol. 9, pp. 423-27, 1921) permits of the division of the radio-active isotopes into three, or even four, classes.

(1) Isotopes of the first class are elements which possess only the same nuclear charge and the same arrangement of their outer electrons, *e.g.* Ra and $MsTh_1$.

(2) Isotopes of the second class have, in addition, the same nuclear mass (*i.e.* the same atomic weight) and the same total number of nuclear "building stones," *e.g.* Io and UY.

(3) Isotopes of the third class still possess the same number of each nuclear building stone, but they have a different arrangement of these in the atomic nucleus, and thus also different chances of disintegrating, *e.g.* RaD and AcB.

(4) Isotopes of the fourth class would be elements possessing the same arrangement of the nuclear building stones in the atomic nucleus, and thus the same probability of disintegration. Such elements actually exist, but we have no available means of distinguishing between them. Hence we cannot at present designate them as isotopes (*e.g.* RaG and AcD).

The branching of the uranium family at U_{II} thus ends with the end-product of the radium- and actinium-family. This common end-product of the two radio-active families is lead with the atomic weight 206.

The more detailed discussion of this subject will appear in the *Zeitschrift für physikalische Chemie*.

M. L. NEUBURGER.

Neubaugasse 79, Vienna, VII., September 16.

Water Power Development.[1]

By PROF. A. H. GIBSON, D.Sc.

THE extent to which the water powers of the world have been investigated and developed during the past decade forms one of the striking engineering features of the period. Although falling or flowing water formed the earliest of the natural sources of energy to be utilised for industrial purposes, it is of interest to note that two-thirds of the water power at present in use has been developed within the last ten years.

The urgent demand for energy to supply the abnormal requirements of the war period, combined with the world shortage of fuel, was responsible for an unprecedented rate of development in most countries with available water-power resources, and especially in those countries normally dependent on imported fuel.

World's Available Water Power.—During the past few years much attention has been paid to statistics of available and developed water powers, and it appears that the available horse-power of the world is of the order of two hundred millions, of which approximately twenty-five millions is at present developed or is in course of development.

Power Available in Great Britain and in the British Empire.—With the noteworthy exceptions of Canada and New Zealand, practically nothing had been done, prior to 1915, by any part of the British Empire to develop or even systematically to investigate the possibilities of developing its water powers. It is true that a number of large installations had been constructed in India and Tasmania, but their aggregate output was relatively inconsiderable.

Since then, however, there has been a general tendency to initiate such investigations, and at the present time these are being carried out with varying degrees of thoroughness in India, Ceylon, Australia, South and East Africa, and British Guiana. While it is known that there is ample water power in Newfoundland, Nigeria, Rhodesia, Papua, and the Gold Coast, no very definite information is available, nor are any steps apparently being taken to obtain data in these countries.

The Water-power Committee of the Conjoint Board of Scientific Societies, which has been studying the state of investigation and development throughout the Empire since 1917, has, however, come to the conclusion that its total available water-power resources are at least equivalent to between fifty and seventy million horse-power.

Of the developed power in the Empire about 80 per cent. is in Canada. Throughout the remainder of its territories only about 700,000 horse-power is as yet developed, or only a little more than 1 per cent. of the power available, a figure which compares with about 24 per cent. for the whole of Europe, and 21 per cent. for North America, including Canada and the U.S.A. These figures sufficiently indicate the relatively large scope for future development.

With a view of ascertaining the resources of our own islands, a Board of Trade Water-power Resources Committee was appointed in 1918. This Committee, which has just presented its final report, has carried out preliminary surveys of as many of the more promising sites as its limited funds allowed, and has obtained data from the Board of Agriculture for Scotland, the Ordnance Survey Department, the Ministry of Munitions, and from civil engineers in private practice, regarding a large number of other sites.

As might be anticipated, Scotland, with its comparatively high rainfall, mountainous area, and natural lochs, possesses relatively greater possibilities than the remainder of the United Kingdom, and investigation has shown that it offers a number of comparatively large schemes. Nine of the more immediately promising of those examined by the Committee have an average output ranging from 7000 to 40,000 continuous 24-hour horse-power, and an aggregate capacity of 183,000 horse-power, while in every case the estimated cost of construction is such that power could be developed at a cost appreciably lower than from a coal-fired station built and operated under present-day conditions. The aggregate output of the Scottish schemes brought before the notice of the Committee, some of which, however, are not commercially feasible at the moment, is roughly 270,000 continuous horse-power.

In addition to these there are a very large number of other small schemes which have not yet been investigated,[2] and it is probably well within the mark to say that there are water-power sites in the country capable of developing the equivalent of 400,000 continuous horse-power, or 1,500,000 horse-power over a normal working week, at least as cheaply as from a coal-fired installation.

A number of attractive schemes are also available in North Wales, though these are in general more expensive than those in Scotland.

Owing to the general flatness of the gradients, there are, except possibly around Dartmoor, no schemes of any large individual magnitude in England, but there are a large number of powers ranging from 100 to 1000 horse-power which might be developed from river flow uncontrolled by storage.

Investigations on a few typical watersheds throughout England and Wales appear to show that the possible output averages approximately eight continuous horse-power per square mile of catchment area, which would be equivalent to an

[1] Abridged from the presidential address delivered to Section G (Engineering) of the British Association at Edinburgh on September 9.

[2] In a paper read before the Royal Society of Arts on January 25, 1918, Mr. A. Newlands gave a list of 122 potential Scottish schemes, the capacity of which he estimated, on a very conservative basis, at 375,000 horse-power.

aggregate of about 450,000 horse-power. Although much of this potential output is not commercially feasible, it would give the equivalent of 500,000 horse-power over a normal working week if only 30 per cent. of it were fully utilised.

In the report recently issued by the Irish Sub-Committee of the Board of Trade Water-power Committee it is estimated that approximately 500,000 continuous 24-hour horse-power is commercially available in Ireland, and that if utilised over a 48-hour working week, its capacity would be at least seven times as great as that of the engine power at present installed in the country for industrial purposes.

It appears then that, although the water-power possibilities of the United Kingdom are small in comparison with those of some more favoured countries, they are by no means so negligible as is commonly supposed, even in comparison with the present industrial steam-power resources of the country.

The capacity of the fuel-power plants installed for industrial and public utility services in the United Kingdom in 1907 was approximately 9·8 million horse-power. Allowing for an increase of 15 per cent. since then, and an average load factor of 35 per cent., this is equivalent to 32,000 million horse-power hours per annum, or to a continuous 24-hour output of only 3·7 million horse-power.

According to Sir Dugald Clerk, the average consumption of coal per horse-power hour in this country is about 3·9 lb., which, on the above basis, would involve a total annual consumption of fifty-five million tons for industrial purposes, not including railways or steamships.

Adopting this figure of 32,000 million horse-power hours as the annual demand for power for industrial purposes, it appears that the inland water-power resources of the United Kingdom are capable of supplying about 27 per cent. of this, a proportion which, in such an industrial country as our own, is somewhat surprisingly large.

Many of the small powers would be well adapted for linking up, as automatic or semi-automatic stations, into a general network of electricity supply, or for augmenting the output of municipal supply works, as has been done so successfully, for example, at Chester, Worcester, and Salisbury.

The development of the many small schemes available in the Scottish Highlands would probably have a great effect on the social life of the community. It would go far towards reviving and extending those small local industries which should form an essential feature of the ideal rural township. Commercially such undertakings may appear to be of small importance, but as a factor in promoting the welfare of the State, economical and political, their influence can hardly be overestimated.

Some of the larger schemes in Scotland would lend themselves admirably to transmission to its industrial districts, while others, in close vicinity to the sea-board, would appear to be well adapted for supplying chemical, or electro-physical, or metallurgical processes.

Conservation.—The importance of water-power development from the point of view of conservation of natural resources requires no emphasis. When the value of coal purely as a chemical asset, or as a factor in the manufacture of such materials as iron and steel, cement, etc., is considered, its use as a fuel for power purposes, when any other equally cheap source of energy is available, would appear, indeed, to be unjustifiable.

The consumption of coal in the best modern steam plant of large size, giving continuous output, would be about nine tons per horse-power year, and on this basis the world's available water power if utilised would be equivalent to some 1,800,000,000 tons of coal per annum. The world's output of coal in 1913 was approximately 1,200,000,000 tons, of which about 500,000,000 tons were used for industrial power purposes, so that on this basis 55,000,000 continuous water horse-power would be equivalent to the world's industrial energy at that date.

Not only does the use of water power lead to a direct conservation of fuel resources, but it also serves to a notable degree to conserve man power. To take an extreme example, each of the 40,000 horse-power units now being installed at Niagara Falls will require for operation two men per shift. It is estimated that to produce the same power from a series of small factory steam plants, more than eight hundred men would be required to mine, hoist, screen, load, transport by rail, unload, and fire under boilers the coal required, while, if account be taken of the additional labour involved in horse transport, wear and tear of roads and of railroad tracks and rolling stock, the number would be considerably increased.

Uses of Hydro-Electric Energy.—While a large proportion of the energy developed from water power is utilised for industrial purposes and for lighting, power, and traction, an increasing proportion is being used for electro-chemical and electro-metallurgical processes.

In Norway the electro-chemical industry absorbed 770,000 horse-power in 1918, or approximately 75 per cent. of the total output, as compared with 1500 horse-power in 1910. Of this some 400,000 horse-power was utilised in nitrogen fixation alone.

The production of electric steel in the U.S.A. increased from 13,700 tons in 1909 to 24,000 tons in 1914, and to 511,000 tons in 1918, this latter quantity absorbing 300 million kw. hours, equivalent to almost 400,000 continuous horse-power.

In Canada, in 1918, the pulp and paper industry absorbed 450,000 horse-power, or 20 per cent. of the total, while the output of central electric stations amounted to 70 per cent. of the total.

The electrification, on a large scale, of trunk line railways is also a probability in the not distant future. In the U.S.A. 650 miles of the main line of the Chicago, Milwaukee, and St. Paul Railway, comprising 850 miles of track, have been electrified, the power for operation being

obtained from hydro-electric stations. In France much of the track of the Compagnie du Midi in the region of the Pyrenees has been electrified with the aid of water power; much of the Swiss railway system has been electrified; and the electrification of many other trunk lines on the European continent is at present under consideration.

Quite apart from the probable huge demand in the distant future for energy for the manufacture of artificial fertilisers by some system of nitrogen fixation, agriculture would appear to offer a promising field for the use of hydro-electric power.

Much energy is now being utilised in the U.S.A. for purely agricultural purposes. In California, for example, there is in effect one vast system of electrical supply extending over a distance of 800 miles with 7200 miles of high-tension transmission lines. This is fed from seventy-five hydro-electric stations, inter-connected with forty-seven steam plants, to give a total output of 785,000 horse-power. A further group of thirteen hydro-electric schemes now under construction will add another 520,000 horse-power. A large proportion of this power is used in agriculture, and a census in 1915 showed that electric motors equivalent to more than 190,000 horse-power were installed on Californian farms. The Californian rice industry is almost wholly dependent on irrigation made possible by electric pumping, while most of the mechanical processes involved in farming are being performed by electric power.

There can be little doubt that the economic development of many of our tropical dependencies is bound up in the development of their water-power resources. Not only would this enable railroads to be operated, irrigation schemes to be developed, and mineral deposits to be mined and worked, but it would also go far to solve the black labour problem, which promises to be one of some difficulty in the near future.

While those outlets for electrical energy which are now in sight promise to absorb all the energy which can be cheaply developed for many years to come, there are many other probable directions in which cheap energy would find a new and profitable outlet. Among these may be mentioned the purification of municipal water supplies, the sterilisation of sewage, the dehydration of food products, and the preservation of timber.

Research in Hydro-Electric Problems.—There are few branches of engineering in which research is more urgently required and in which it might be more directly useful.

Among the many questions still requiring investigation on the civil and mechanical side may be mentioned:—

1. *Turbines.*—Investigation of turbine corrosion as affected by the material and shape of the vanes.

Effect of erosion due to sand and silt.

Resistance to erosion offered by different materials and coatings.

Bucket design in low head high-speed turbines.

Draft tube design.

Investigation of the directions and velocities of flow in modern types of high-speed turbines.

Investigation of the degree of guidance as affected by the number of guide and runner vanes.

2. *Conduits and Pressure Tunnels.*—The design of large pipe lines under low heads with the view of reducing the weight of metal. The investigation of anti-corrosive coatings, so as to reduce the necessity for additional wall thickness to allow for corrosion.

Methods of strengthening large thin-walled pipes against bending and against external pressures.

Methods of lining open canals and of boring and lining pressure tunnels.

Effects of curvature in a canal or tunnel.

3. *Dams.*—Most efficient methods of construction and best form of section especially for rock-fill and earthen dams. Best methods of producing water tightness.

4. *Run-off Data.*—Since the possibility of designing an installation to develop the available power efficiently and economically depends in many cases essentially on the accuracy of the run-off data available, the possession of accurate data extending over a long series of years is of great value.

While such data may be obtained either from stream gaugings or from rainfall and evaporation records, the former method is by far the more reliable. For a reasonable degree of accuracy, however, records must be available extending over a long period of years, and at the present moment such data are available only in very few cases.

Where accurate rainfall and evaporation records are available, it is possible to obtain what is often a sufficiently close approximation to the run-off, but even rainfall records are not generally at hand where they are most required, and even in a district where such records are available, they are usually confined to easily accessible points, and are seldom extended to the higher levels of a catchment area where the rainfall is greatest. Even throughout the United Kingdom our knowledge of the rainfall at elevations exceeding 500 ft. is not satisfactory, and little definite is known concerning that at elevations exceeding 1000 ft.

In this country evaporation may account for between 20 and 50 per cent. of the annual rainfall, depending on the physical characteristics of the site, its exposure, mean temperature, and the type of surface covering. In some countries evaporation may account for anything up to 100 per cent. of the rainfall. As yet, however, few records are available as to the effect of the many variables involved. An investigation devoted to the question of evaporation from water surfaces, and from surfaces covered with bare soil and with various crops, under different conditions of wind, exposure, and mean temperature, would appear to be urgently needed. If this could be combined with an extension of Vermeulle's investigation into the relationship between rainfall, evaporation, and run-off on watersheds of a few characteristic types, it would do much towards enabling an accu-

rate estimate of the water-power possibilities of any given site to be predetermined.

Even more useful results would follow the initiation of a systematic scheme of gauging applied to all streams affording potential power sites.

Tidal Power.—The question of tidal power has received much attention during the last few years. In this country it has been considered by the Water-power Resources Committee of the Board of Trade, which has issued a special tidal power report dealing more particularly with a suggested scheme on the Severn. The outline of a specific scheme on the same estuary was published by the Ministry of Transport towards the end of 1920.

In France a special commission has been appointed by the Ministry of Public Works to consider the development of tidal power, and it has been decided to erect a 3000 kw. experimental plant on the coast of Brittany. With the view of encouraging research the Government proposes to grant concessions, where required, for the laying down of additional installations.

The tidal rise and fall around our coasts represents an enormous amount of energy, as may be exemplified by the fact that the power obtainable from the suggested Severn installation alone, for a period of eight hours daily throughout the year, would be of the order of 450,000 horse-power.

Many suggestions for utilising the tides by the use of current motors, float-operated air compressors, and the like have been made, but the only practicable means of utilising tidal energy on any large scale would appear to involve the provision of one or more dams, impounding the water in tidal basins, and the use of the impounded water to drive turbines.

The energy thus rendered available is, however, intermittent; the average working head is low and varies daily within very wide limits, while the maximum daily output varies widely as between spring and neap tides.

If some electro-chemical or electro-physical process were available, capable of utilising an intermittent energy supply subject to variations of this kind, the value of tidal power would be greatly increased. At the moment, however, no such process is commercially available, and in order to utilise any isolated tidal scheme for normal industrial application it is necessary to provide means for converting the variable output into a continuous supply constant throughout the normal working period.

Various schemes have been suggested for obtaining a continuous output by the co-ordinated operation of two or more tidal basins separated from each other and from the sea by dams with appropriate sluice gates. This method, however, can get over the difficulty of equalising the outputs of spring and neap tides only if it be arranged that the maximum rate of output is that governed by the working head at the lowest neap tide, in which case only a small fraction of the available energy is utilised.

When a single tidal basin is used it is necessary to provide some storage system to absorb a portion of the energy during the daily and fortnightly periods of maximum output, and for this purpose the most promising method at the moment appears to involve the use of an auxiliary high-level reservoir into which water is pumped when excess energy is available, to be used to drive secondary turbines as required. It is, however, possible that better methods may be devised. Storage by the use of electrically heated boilers has been suggested, and the whole field of storage is one which would probably well repay investigation.

If a sufficiently extensive electrical network were available, linking up a number of large steam and inland water power stations, a tidal power scheme might readily be connected into such a network without any storage being necessary, and this would appear to be a possibility which should not be overlooked in the case of our own country.

Investigation necessary.—A tidal power project on any large scale involves a number of special problems for the satisfactory solution of which our present data are inadequate.

Thus the effect of a barrage on the silting of a large estuary, and the exact effect on the level in the estuary and in the tidal basin at any given time can only be determined by experiment, either on a small installation, or preferably on a model of the large scheme.

Many of the hydraulic, mechanical, and electrical problems involved are comparatively new, and there is little practical experience to serve as a basis for their solution.

Among these may be mentioned:—

1. The most advantageous cycle of operations as regards working periods, mean head, and variations of head.
2. The methods of control and of sluice-gate operation.
3. Effect of changes of level due to wind or waves.
4. The best form of turbine and setting and the most economical turbine capacity.
5. The possibilities of undue corrosion of turbine parts in salt water.
6. The best method of operation; constant or variable speed.
7. Whether the generators shall be geared or direct driven.
8. Whether generation shall be by direct or alternating current.

The questions of interference with navigation and with fisheries, of utilising the dam for rail or road transport across the estuary, and, above all, economic questions connected with the cost of production, and the disposal of the output of such an installation, also require the most careful consideration before a scheme of any magnitude can be embarked upon with assurance of success.

In view of the magnitude of the interests involved, and of the fact that rough preliminary estimates indicate that to-day current even for an ordinary industrial load could be supplied from such an installation at a price lower than from a steam generating station giving the same output

with coal at its present price, it would appear desirable that these problems should receive adequate investigation at an early date.

Facilities for Research in Hydraulic and Cognate Problems.—In view of the considerations already outlined, and especially in view of the large part which British engineering will probably play in future water-power developments, the provision on an adequate scale at some institution in this country of facilities for research on hydraulic and cognate problems connected with the development of water power is worthy of serious attention.

At present the subject is treated in the curriculum of the engineering schools of one or two of our universities, but in no case is the laboratory equipment really adequate for the purpose in question.

What is required is a research laboratory with facilities for experiments on the flow of water on a fairly large scale; for carrying out turbine tests on models of sufficient capacity to serve as a basis for design; and, if possible, working in conjunction with one or more of the hydro-electric stations already in existence, or to be installed in the country, at which certain large-scale work might be carried out.

The provision of such a laboratory is at present under consideration in the United States, and in view of the rapidity with which the designs of hydraulic prime movers and their accessories are being improved at the moment, it would appear most desirable that the British designer, in order that the deservedly high status of his products should be maintained and enhanced, should at least have access to equal facilities, and, if necessary, be able to submit any outstanding problems to investigation by a specially trained staff.

The extent to which our various heat engine laboratories have been able of recent years to assist in the development of the internal combustion engine, and to which our experimental tanks have assisted in the development of the shipbuilding industry, is well known to most of us, and the provision of similar facilities to assist in the development of our hydro-electric industry would probably have equally good results in this connection.

The Danish Deep Sea Expedition.

THE Danish Deep Sea Expedition, which left Copenhagen on August 30 on board the new research steamer *Dana*, is expected to spend about ten months in the temperate and tropical parts of the North Atlantic. The object of the expedition is to carry out deep sea investigations in accordance with a scheme which was submitted by the leader of the expedition, Dr. Johs. Schmidt, to the International Council for the Exploration of the Sea during their meeting at Copenhagen in July last.

FIG. 1.—S.S. *Dana*.

The committee of the expedition consists of the members of the official Danish "Committee for the Study of the Sea" and of several other Danish men of science interested in oceanography. The president is Commander C. F. Drechsel, and the vice-president Vice-Admiral C. F. Wandel (leader of the Danish Ingolf Expedition in 1895–96). Admiral H.R.H. Prince Valdemar of Denmark is patron of the expedition. The expenses are being defrayed by funds supplied by various private persons and by the Danish Government annual grants for marine investigations in connection with the International Council for the Exploration of the Sea.

The ship of the expedition, the *Dana* (Fig. 1), of the Lord Mersey trawler type, was bought in England by the Danish Government to replace the old research steamer *Thor*, which was sold some years ago. The *Dana* has been equipped for marine research work at the Royal Dockyard, Copenhagen. She has a length of about 140 ft. between perpendiculars, and is 325 tons gross register. She carries a 600-h.p. triple expansion engine, giving her a speed of 9 knots. A large deck-house has been constructed, which contains two laboratories—a larger biological laboratory with accommodation for five workers, and a smaller one for hydrographical work with room for two—together with a mess-room for the scientific staff, and a cabin for the

leader of the expedition. Below deck are the cabins of the scientific staff, and store-rooms for the various instruments, fishing gears, collections, etc. The winches are worked by steam. A big trawl-winch placed forward has two drums, the smaller carrying 4000 metres of steel-wire 14 mm. in diameter for trawling at moderate depths, and the larger, carrying 10,000 metres of steel-wire tapering from 14 mm. to 7 mm. in diameter, to be used for greater depths. The three winches for vertical hauls (water-bottles, plankton nets, and sounding) are placed on the port side of the ship; one works the Lucas sounding machine and a drum carrying 6000 metres of phosphor-bronze wire; another is a small hand-winch to be used for the surface layers; and the third works a big drum carrying 10,000 metres of steel-wire 4 mm. in diameter. The steel-wire ropes have been supplied by Messrs. Craven and Speeding Bros., Sunderland, and the hydrographical instruments by the Laboratoire Hydrographique, Copenhagen, of which Prof. Martin Knudsen is director.

The *personnel* of the expedition is as follows:—Dr. Johs. Schmidt, leader of the expedition; Dr. J. N. Nielsen (Meteorological Institute, Copenhagen), hydrographer; P. Jespersen and A. V. Taaning (Danish Committee for the Study of the Sea); K. Stephensen (Zoological Museum, Copenhagen); J. Olsen (Polytechnic College, Copenhagen), assistant hydrographer. N. C. Andersen, ship's doctor, will also take part in the investigations. Prof. C. H. Ostenfeld expects to join the expedition later on during its stay in West Indian waters.

The *Dana* is under the command of Capt. G. Hansen, who served for many years as captain of the research steamer *Thor*.

Further particulars of the expedition are given in the subjoined *résumé* of a lecture delivered by Dr. Johs. Schmidt at the meeting of the International Council for the Exploration of the Sea at Copenhagen in July last.

The object of the expedition is to study the oceanographical conditions of the open North Atlantic Ocean. By oceanographical conditions is meant not only the physical, but also the biological conditions of the ocean, and in combining investigations of both it is hoped to obtain some insight into the problems of the relation of the biology of the ocean to some of the physical factors which it will be possible to trace. The principal aim, therefore, is of a very general nature. There are in addition, however, some tasks of a more special nature, the most important of which is an investigation of the oceanic portions of the life-histories of the common eel and the conger; further, the biology of other oceanic fishes, such as the various large scomberoids, dolphins, sword-fishes, sun-fishes, flying-fishes, and others, will be studied.

We know too little about the general biology of the ocean to be able to do our work from biological points of view alone; it has therefore been considered wiser to allow hydrographical views to dictate the course of the expedition. To put it briefly, we shall work biologically at each hydrographical station.

We do not expect to be able to pay much attention to the bottom of the ocean and its fauna; this would require more time than we have at our disposal. On the other hand, we shall try to concentrate our efforts on a study of the water-mass itself, which on an average has a depth of about 4000 metres in the North Atlantic. Our plan is to investigate not only the upper water layers, but also the intermediate layers and those covering the bottom, and we intend to do this in regard to their temperature, salinity, and gas-content, and also their fauna. Afterwards we shall compare the data we have obtained in this way in order to try to understand something of the physical factors which control the occurrence of the various pelagic communities of animals and plants, in regard to both their horizontal and vertical distribution. If possible, we shall pay special attention to the fauna of the deeper and deepest water layers of the ocean.

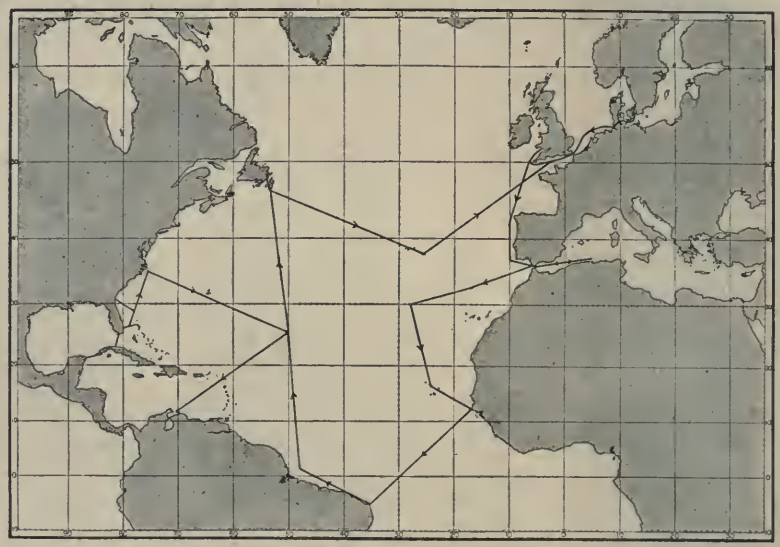

FIG. 2.—Planned routes of the *Dana* Expedition, 1921–22.

A current-chart of the North Atlantic shows that the most conspicuous feature is the great anticyclonic rotation of the superficial water-masses with the Sargasso Sea forming, so to speak, a centre of the rotation. Our plan is to investigate this great anticyclonic system, and we propose to do it by means of several cross-sections radiating from the centre, the Sargasso Sea, which, in more than one respect, will be our principal field of work (Fig. 2).

First, there is the inflow of water from the South Atlantic and the south equatorial current, which passes the boundary between the North and South Atlantic joining the current system of the North Atlantic. We propose to investigate carefully this boundary region between the North and South Atlantic, and we shall do this by means of a section between Africa and Brazil about the region where the Atlantic Ocean is narrowest. Through this section

enormous water-masses of South Atlantic origin are passing at the surface with great speed, and the cold water flowing along the bottom has, so far as we know, the same course. It follows from this that intermediate water-masses must move in the opposite direction, from the North to the South Atlantic. We hope to be able to do some useful work in this boundary region by studying the interaction between the water-masses of the northern and the southern Atlantic and their pelagic life.

The study of the equatorial current brings us in close contact with another important problem: the origin of the so-called Gulf Stream. We intend to study this by means of sections from the Sargasso Sea to the north coast of South America through the Caribbean Sea, and from the Sargasso Sea to the east coast of the United States. It seems clear that water passing both south and north of the West Indies must take part in the formation of the Gulf Stream. We hope that our sections taken before and after the junction of the water-masses coming from Florida Strait and of those passing north of the West Indies will help us to determine their relative importance in the formation of the Gulf Stream.

The centre of the North Atlantic rotation is the Sargasso Sea, a region which seems to merit a careful hydrographical investigation. Probably we shall be able to spend a good deal of time here on account of the eel investigations. It is impossible to say how long we shall be kept in the Sargasso Sea and West Indian waters, and it depends on this how much we shall be able to do during the homeward voyage of the expedition. If time permits we shall certainly make one or more cross-sections of the Gulf Stream or the Atlantic rotation, first one from the Sargasso Sea to Newfoundland, and perhaps another from there to the Azores.

This is a very brief sketch of our working scheme. Time will show to what extent we shall be able to carry it through.

Industrial Micro-biology.

IT is not much more than half a century since Pasteur began to study some chemical effects of micro-organisms which led him to the foundation of the new science of bacteriology. In the application of Pasteur's results to medicine this country has not been behind, and in the investigation of diseases due to protozoa it has been in the forefront. We have, however, neglected the application of Pasteur's work to industry. Yeast has been studied successfully in England, yet we cannot be said to lead in this department. Past British achievements in the chemistry of fermentation have been recently recorded by Prof. Armstrong in his Adrian Brown memorial lecture (see NATURE for July 28, p. 698). It is chiefly in the other industrial uses of micro-organisms that we are behind France and Germany in many respects; the Danish dairy industry has made far better use of bacteriology than has ours. Accordingly we must be grateful when a leading expert like Mr. Chaston Chapman reviews recent achievements and the present position in a series of lectures.[1]

Starting from the discovery of zymase by Büchner in 1897, Mr. Chapman discusses the work of Harden and his colleagues on its co-enzyme, and then refers to the German manufacture of glycerine by fermentation during the late war. In 1858 Pasteur first directed attention to the constant occurrence of glycerine in the fermentation of sugar solutions, and put the yield at about 3 per cent. of the sugar employed. Later 7 or 8 per cent. has been occasionally recorded, but Connstein and Lüdecke have shown that in the presence of various alkaline salts the yield of glycerine may regularly amount to 10 per cent.; in a concentrated solution of sodium sulphite it may even reach 36 per cent. of the sugar employed (usually molasses). A yield of 1000 tons a month is stated to have been attained during the war. The process was kept secret until after the armistice, and hence it is difficult to know to whom most credit should be assigned. Mr. Chapman states that Germany was actually producing large quantities of glycerine by fermentation early in 1917, and he thinks it probable that the initial experiments were made very shortly after—if not before—the outbreak of war. He also refers to a less known report from the laboratory of the Internal Revenue Bureau in Washington, dated May 6, 1918, which makes it clear that the American authorities had then also devoted much attention to the problem, and with considerable success.

In his lectures Mr. Chapman is not so much concerned with the commercial aspect of this manufacture as with the illustration it affords how, "by the application of the necessary study, an ancient and very familiar biological process may be made to yield as much as 40 per cent. of a substance which had hitherto been regarded merely as an unimportant by-product."

A second example of the application of modern biochemical methods to an ancient industry is furnished by the "amylo" process for the direct conversion of starch into alcohol by certain moulds. Such fungi have been used for centuries in China for the preparation of potable spirit from rice, for they produce not only an amylase, but also a zymase, combining, therefore, the functions of malt and of yeast. After an investigation by Calmette, the first large-scale trials were made in a French distillery in 1898, and for 1916 the output of alcohol by this process in France is stated to have been 665,232 hectolitres (14 million gallons). In this country the "amylo" process cannot be used, owing to Excise regulations. Mr. Chapman points the moral:

> No Government can afford to ignore scientific discoveries and industrial developments . . . and if there is one thing which, during recent years, has been made more apparent than another, it is that the country which is foremost in the encouragement of scientific men and in the utilisation of their dis-

[1] "Micro-organisms and some of their Industrial Uses." The Cantor Lectures. By A. Chaston Chapman. Journ. Roy. Soc. of Arts, 1921, vol. 69, pp. 581–89, 597–605, 609–19.

coveries will ultimately win the race at the expense of those which have been more neglectful in that respect. The possession by the latter of greater natural resources will only serve to stave off defeat for a time.

Moulds may be trained, under certain conditions, to produce various other compounds from sugar—for example, up to 50 per cent. of citric acid, also fumaric and pyruvic acids. Lactic acid and vinegar are, of course, largely manufactured by fermentation, but Mr. Chapman deplores the way in which these industries have neglected to apply modern scientific results. In the manufacture of vinegar, in particular, no real progress has been made since Pasteur's work of 1868.

We have been more successful with the production of acetone and butyl alcohol from starch, but this, too, originated in France in the experiments of Fernbach. Mr. Chapman discusses the process in some detail; in normal times its commercial success will depend on a means of utilising the butyl alcohol, which is produced in twice the quantity of the acetone.

Other applications of micro-biology are to agriculture, bread-making, tanning, sewage disposal, and food-production. Brewers' yeast is almost a waste product to the extent of 50,000 or 60,000 tons per annum in the United Kingdom, but is being used more and more as a cattle food and, in the shape of an extract, for human consumption. "Mineral yeast" (not a true yeast) was grown in Germany as a war food.

Finally, Mr. Chapman reiterates his plea (already made in a paper to the Society of Chemical Industry) for the foundation of a National Institute of Industrial Micro-biology, which should provide for the systematic prosecution of industrial research, be a centre for specialised training, and maintain a complete collection of pure cultures. "For far too many years we have been content to act as middlemen and agents, when we ought to have been manufacturers."

Obituary.

G. W. Walker, F.R.S.

BY the death of Mr. George Walker Walker, physical science has lost a brilliant exponent of its rigidly exact experimental side, which his high mathematical attainment and inventive capacity enabled him to develop with marked success.

Mr. Walker was the only son of Mr. John Walker, of Aberdeen, and was a foundationer at the Robert Gordon's College, Aberdeen. He started life as a practical engineer, but, not caring for this, he obtained an appointment with Messrs. C. & P. H. Chalmers, of Aberdeen, where he remained one year. His interest in science, however, led him to pursue its study in the evening classes of Gordon's College, where he received so much help and encouragement that he obtained a national scholarship, which brought him in 1892 to the Royal College of Science, South Kensington, where, in due time, he obtained his associateship. While at South Kensington he so impressed Sir Arthur Rücker with his mathematical ability that he urged him to go to Cambridge, where he obtained a Sizarship at Trinity College. He was fourth wrangler in 1897, and Smith's prizeman and Isaac Newton student in 1899, and was appointed a fellow of Trinity in 1900. In 1901 he studied at Göttingen. From 1903 to 1908 he was lecturer in physics at Glasgow University. He was then appointed superintendent of Eskdalemuir Observatory, for which his prior training at South Kensington so admirably fitted him. There he remained four years. From 1912 to 1915 he was engaged on the new magnetic survey of the British Isles. He was elected a fellow of the Royal Society in 1913. He assisted the Earl of Berkeley in his laboratory at Boar's Hill in 1915, and became Halley lecturer in 1916.

In May, 1918, Mr. Walker was appointed chief scientific worker at the Royal Naval Mining School, Portsmouth, where the numerous and urgent problems connected with marine mines afforded abundant scope for his genius. His success in dealing with these was properly appreciated by the Superintendent of Mining and other naval officers, but this work, from its nature, is essentially confidential. In November, 1920, while engaged on experimental work at Falmouth, he contracted a chill, which developed into lung trouble and was the cause of an abscess, for which operation became necessary. He went into University College Hospital, Gower Street, in July last, where the shock due to two operations led to his death.

Besides his work on magnetic surveying, Mr. Walker was an authority on seismology, being also a warm admirer of Prince Galitzin. In 1904 he married the daughter of Mr. Gifford, of Aberdeen, who, with one son, survives him.

C. V. B.

Dr. Peter Cooper Hewitt.

Dr. Peter Cooper Hewitt, who died in Paris on August 25 last, at the age of sixty years, was the son of a leading New York iron manufacturer and merchant well known as the promoter of many civic, educational, and philanthropic causes. His mother was the daughter of Peter Cooper, an inventor, manufacturer, and railroad builder, who presented New York with the Cooper Union for the advancement of art and science, now more usually known as Cooper Institute.

Dr. Cooper Hewitt was born on March 5, 1861, and was educated at the Stevens Institute of Technology at Hoboken, New Jersey, and at the Columbia University School of Mines. He early manifested a strong inclination towards mechanics, and his course of studies was directed towards the mechanical, chemical, and electrical sciences. One of his earliest inventions was in relation to improvements in the machinery em-

ployed in his grandfather's glue factory, and he followed this up with new forms of centrifugal machines, evaporators, and other devices for use in breweries. He made many experiments and a number of inventions in connection with motor vehicles and flying machines, and in later years devoted a considerable amount of time to the study of the helicopter.

About 1898 Dr. Cooper Hewitt directed his attention to electrical science, and became a contributor to scientific discovery in a diversity of fields, from wireless telegraphy and telephony to a special process for the electrical welding of steel. However, his name is probably best known in connection with his fundamental work relating to the mercury vapour arc which he brought into commercial use when he founded, in conjunction with the late Mr. George Westinghouse, the Cooper Hewitt Electric Company of New York, and the Westinghouse Cooper Hewitt Company, now known as Hewittic Electric Company, Limited, in England. His original work on the mercury vapour rectifier has been followed up until this apparatus has become a most useful adjunct to the dynamo, not only in street lighting but also in the serious work of power distribution, and it has not yet been brought to its full industrial value. A generation hence the world will have begun to reap some of the larger benefits conferred by the discoveries of this notable scientific worker.

WE regret to learn of the death of MR. BINGHAM NEWLAND, an observant and original naturalist, author of "What is Instinct?", which was reviewed some time ago in these columns. Mr. Newland held very strong views in regard to the infallibility of the subconscious mind in animals, and thought of this as strangely detached from individual testing, experimenting, and learning. Perhaps what he was feeling towards was a theory of the germinal origin of new departures in instinctive behaviour. Another of his amiable heresies was a belief in "mind-blending" or telepathic communication in birds, by means of which effective co-operation is achieved. Mr. Newland's original and independent mind was handicapped by ill-health, but he had the reward of all those who read deeply in the book of Nature.

Notes.

WE much regret that the reference to the Calcutta munitions case in last week's NATURE, p. 160, did not accurately represent Sir Thomas Holland's position in the matter. It was Sir Thomas Holland himself who, acting on the highest motives and after consultation with two members of the Viceroy's Council, ordered the withdrawal of the prosecution, but when all the facts are published we believe that the real reason for his action will reveal more than the stated reason as to the harm that might be done to Indian industrial development if it succeeded. As the Government of India could not support the view publicly stated, Sir Thomas Holland's resignation of the post of Minister of Industries naturally followed. Later, however, it was officially announced that the prosecution would not be proceeded with because "widespread commercial and industrial interests would be seriously affected," though when the Advocate-General withdrew from the case on August 6 he declared that all the charges could be proved. This decision seems, therefore, to support Sir Thomas Holland's action; and, notwithstanding the suggestion that the Minister of Industries should have received legal training, his reputation as a scientific administrator is safe with all who realise what the building-up of the Indian Munitions Board during the stress of war meant for India, the Entente Powers, and the final victory.

IN memory of those lost in R38 and in previous airships, a decision to establish a fund for airship research has been made by the council of the Royal Aeronautical Society. It is believed that such a course of action would most nearly meet the wishes of those who have lost relatives and friends in the disaster. It is important for the country that the lessons should not be lost, and the view of those most closely connected with airships is that analysis of the causes of the breaking of R38 in the air can give the foundation for a sound system of construction. Such a result would afford some comfort to the relatives of the officers and men who gave their lives for progress, and, in view of the well-known decision of the Air Ministry to cease all work on airships, it is desirable that others should take up the problems connected with their development. The memorial fund is to be devoted to this end. Over the signature of Lord Weir, the president of the society, an appeal for contributions has just been issued, with the suggestion that they should be sent to the Secretary, Royal Aeronautical Society, 7 Albemarle Street, London, W.1.

THE *Times* announces that Mr. Knud Rasmussen's ethnological expedition to the Canadian Arctic Archipelago left Godthaab, on the south-west coast of Greenland, on September 7 in the motor schooner *Sea King*. On his arrival in Greenland in the early summer Mr. Rasmussen went to Thule, near Cape York, to secure Eskimo, dogs, and furs for his expedition. Some delay was caused by pneumonia spreading among the Eskimo and causing two deaths. After a call on the coast of Labrador the *Sea King* will sail for Lyon Inlet, in the Melville Peninsula, which will be the base for the first winter. From there the little-known tribes around Fury and Hecla Strait will be visited by sledge journeys. In the spring of 1922 Mr. Rasmussen plans to move south to Chesterfield Inlet in order to pick up stores sent north by the Hudson Bay Co., and he will then visit tribes in the Barren Lands and along the shores

of Coronation Gulf before returning to Lyon Inlet. The next news of the expedition may be expected from St. John's, Newfoundland, when the *Sea King* returns during the autumn.

THE Royal Microscopical Society has arranged to include in the programme of ordinary meetings during the coming session a series of papers dealing with the practical uses of the microscope in industrial research. A provisional list has been issued of the communications to be read, and from this it appears that a wide range of subjects will be covered by a number of competent authorities. Metallurgy, physical optics, glass, leather, coal, medical research, and brewing, all in relation to the microscope, are among the topics which will be discussed. The first two papers will be read on October 19, when Dr. L. T. Hogben will read a communication entitled: "Preliminary Account of the Spermatogenesis of Sphenodon," and Mr. D. M. Stump will communicate a paper entitled "An Application of Polarised Light to Resolution with the Compound Microscope." Announcements of further papers will be made from time to time in the Diary of Societies published in our columns.

AT a recent meeting of the American Astronomical Society, held at Middletown, Connecticut, Prof. C. V. L. Charlier was elected an honorary member. The only other living astronomers who have been thus honoured are Prof. J. C. Kapteyn and Sir Frank Dyson.

THE fourth annual Streatfeild memorial lecture is to be delivered at the Finsbury Technical College, Leonard Street, E.C.2, by Mr. W. P. Dreaper, on Thursday, October 20, at 4 o'clock. The subject will be "Chemical Industry a Branch of Science." Admission will be free.

THE first general meeting of the Society for Constructive Birth Control and Racial Progress will be held on Thursday, October 13, at 8 p.m., at the Lecture Room, Hotel Cecil, Strand, W.C., when Dr. Marie Stopes will deliver her presidential address, entitled, "Anecdotes of the Past, Present, and Future of Birth Control."

THE Committee of Privy Council for Medical Research has appointed Sir F. W. Andrewes and Sir Cuthbert Wallace to fill the vacancies on the Medical Research Council caused by the retirement of Mr. C. J. Bond and Prof. W. Bullock, in accordance with the provisions for rotation made in the Royal Charter under which the council is incorporated.

IT is announced that Mr. D. Prain, agriculturist, Nyasaland, has been appointed to be senior district agricultural officer in Tanganyika Territory; Mr. H. A. Dade to be assistant mycologist in the Department of Agriculture, Gold Coast; and Mr. J. A. Robotham to be assistant agricultural superintendent, St. Kitts-Nevis.

THE New York correspondent of the *Times* reports that at Dayton, Ohio, Lieut. J. Macready made a new height record when flying a Lapero biplane on September 28. Ice formed in his oxygen tank at 39,000 ft., but his engine carried him on until the altimeter registered 40,800 ft. Lieut. Macready came down and made a successful landing after being 1h. 47m. in the air.

CHARLES DARWIN'S birthplace, known as The Mount, Shrewsbury, situated in that part of the town known as Frankwell, has been purchased by H.M. Office of Works. The house was built about 1800, and at the time when Sir Francis Darwin wrote, in 1887, "The Life and Letters of Charles Darwin," it had undergone but little alteration. It was "a large, plain, square, red-brick house, of which the most attractive feature" was "the pretty greenhouse, opening out of the morning-room."

IT is announced in the *Revue Scientifique* of September 24 that the first award of the Marcel Benoist prize of 20,000 francs has been made to M. Maurice Arthus, director of the Institute of Physiology at Geneva. The prize was founded by M. Benoist, of Paris, who bequeathed his whole fortune to the Federal Council of Switzerland in recognition of the care and attention which he received in that country. An award will be made annually to the man of science who, having been domiciled in Switzerland for five years, is judged to have made the most noteworthy contribution to science, particularly in relation to human life, during the preceding year.

AT the recent meeting of the Hull Museums Committee the curator reported that when in London recently he heard that the specimens in the museum at the Royal Albert Institute, Windsor, were in rooms which were required for other purposes, and that there was an opportunity of obtaining the collections. He consequently visited Windsor, with the result that the whole of the specimens are now in Hull, and among them are many valuable additions to the antiquities and geological and natural history series already there. Particular mention may be made of some pre-historic Bronze Age and Stone Age weapons, a large collection of Roman lamps and pottery, Greek vases, and a miscellaneous series of medieval antiquities. Otherwise the objects are such as were to be found in museums of this character in the early part of the last century. Fortunately a handbook to the collections, written by Mr. J. Lundy, was published many years ago.

A COMPANY has been incorporated, under the name of British Trade Ship, Ltd., with Earl Grey as chairman, for the purpose of carrying out the project of organising a floating exhibition of British goods which shall visit the chief ports of the world. A new vessel of 20,000 tons register is to be constructed in the yards of Messrs. Swan, Hunter and Wigham Richardson, Ltd., and it is intended that she shall leave the Thames in August, 1923, on a tour of more than 42,000 miles, returning to London in February, 1925. South America, South Africa, Australia, New Zealand, Fiji, and Japan will be visited on the outward voyage, and the ship will return *via* China, India, and the

Suez Canal. The ship will be 550 ft. long, with an extreme breadth of 74 ft. 9½ in., and a moulded depth of 44 ft. 6 in. to the shelter deck. She will be built after the style of a first-class liner so far as accommodation for trade representatives, etc., is concerned, but her special feature will be four exhibition decks, long clear spaces the full width and the full effective length of the vessel, and 10 ft. in height between decks. Compressed air, electricity, running shafting, and probably steam and hydraulic power will be provided for exhibitors who may desire to give working demonstrations of their machinery. Other interesting particulars regarding this vessel are given in *Engineering* for September 23. There is no doubt that the scheme will be valuable in carrying out much-needed propagandist work.

"SPEECH in the Silent World" is the title of an address delivered by Sir Leslie Mackenzie at the annual meeting of the Edinburgh Royal Institution for the Deaf and Dumb, in which teaching the deaf mute to articulate is discussed. The author believes that the impulse to speak is almost universal. The normal child at a certain stage acquires language with extraordinary rapidity, and the same obtains with deaf children if they be of normal brain. For the latter the problem of training in articulate speech is like the problem of training in the speech of gesture, namely, how to use a series of motions to express a meaning. Through the series of motions visible to the eye the teacher of lip-speech trains the vocal organs in the formation of sounds with meaning, and the teacher of lip-speech, working on the irresistible impulse towards expression, develops with amazing rapidity the powers of articulation. The training should preferably commence at the age of two or three years; progress is then much more rapid, for as time elapses the impulse becomes less and less marked, and the training in articulate speech correspondingly more difficult. The directors of the Edinburgh Royal Institution last year opened a nursery school so that the training in lip-speech might be commenced at an early stage of life.

THE presidential address delivered by Sir Baldwin Spencer at the meeting of the Australian Association for the Advancement of Science, held at Hobart, Melbourne, in January last, is devoted to the tangled problems of Australian ethnology. After a succinct review of the work of various explorers he gives the well-needed caution that "investigations carried on amongst the remains of tribes that have been long in contact with white men are liable to be very misleading." As regards land tenure, statements of individual ownership should be accepted with caution, as natives perceive that the private possession of land among white men is evidently a sign of superiority. The existence of a number of local tribes, each with its own distinct dialect, is a difficult problem. The desiccation of the central area probably led to the isolation of its inhabitants from the coastal people, and the progressive deterioration of the climate led to the occupation of districts less exposed to drought, where the absence of a written language encouraged the growth of dialects. The original migrants probably entered Australia at the north-east in Pliocene or very early Pleistocene times. The theory of Dr. Rivers that "the history of Australian culture and its present nature become far easier to understand if there has been a gradual infiltration of seafaring peoples, starting from many points on the coast," is dismissed with the remark: "To anyone who has had experience of the wild native tribes on the northern, north-western, and north-eastern coasts there is very considerable difficulty in accepting the suggestion of Dr. Rivers that small seafaring parties landing at various points would be able, even if they could find sufficient food to live upon, to influence the aboriginals. Personally, at that early date, I should have been very sorry to have formed a member of any such small party." This address is very interesting and instructive, and may be commended to all students of Australian ethnology.

WITH the rapid development of water-power utilisation in Italy, increasing attention is being directed to better methods of inland waterway transport and the improvement of existing ports and the planning of new ones. With a view of facilitating a thorough discussion of questions bearing on this subject, the Associazione Nazionale per i Congressi di Navigazione (National Association for Congresses on Navigation) is holding a Congress on "Inland Navigation and Ports" at Ravenna on October 22–26. The Congress, on this occasion, will be confined to questions relating to inland navigation in Northern Italy and the ports of Ravenna, Ferrara, and Venice. A number of papers will be read, visits paid to port works, and, if time permits, an exhibition relative to inland navigation and port works will be arranged. Among the subjects for discussion are: "A Systematic Plan for the Control of the Waterways of Northern Italy"; "Types and Standard Dimensions of Art-works on Inland Waterways"; "Utilisation of Existing Subsidiary Waterways in Northern Italy"; "Suggested Regulations for Inland Navigation on Existing Waterways"; "The Administrative Control of Maritime Ports"; "Distribution and Co-ordination of the Functions of the large Adriatic Ports"; "Works carried out or schemes approved for the Construction and Improvement of Maritime Ports in Italy"; "Present State of Inland Navigation Works recently completed or in course of Construction in Italy"; "Methods of facilitating the Entry of Ships into Ports in Foggy Weather," etc. Those interested may enrol as temporary members of the Congress on payment of 25 lire (100 lire for a company or association). The papers will be printed and circulated to members of the Congress. The general secretary of the Congress is Signor Mario Beretta, Via della Signora 12, Milan.

IN an article on "The Whaling Industry" in the *Statist* for September 3 Mr. A. F. Bearpark advocates a complete scientific investigation of the industry with the view of preventing its extinction, and not, as the writer frankly admits, in order that whales may be preserved from extermination. He does not believe that the latter eventuality is to be feared from the operations of whalers, because economic con-

siderations would bring about the stoppage of the industry before that could occur. He outlines a schedule of information to be demanded as a basis for legislation when licences for whaling are issued, and urges the infliction of heavy penalties for incomplete and inaccurate returns. Most of the information asked for by Mr. Bearpark is, we believe, already supplied by whaling companies, and the masterly analysis of the statistics for the last eight years presented by Sir Sidney Harmer to the recent meeting of the British Association at Edinburgh does not bear out Mr. Bearpark's contention that the extinction of whales is not to be feared from the operations of whalers. The contrary is, unfortunately, only too clearly probable. Whether from the point of view of the naturalist or the whaler, legislation to regulate the industry is undoubtedly necessary, particularly, as Mr. Bearpark points out and as Sir Sidney Harmer would agree, to prevent the deplorable waste which is associated with floating factories. A little friendly co-operation should result in legislation which aims at the consummation of the desires of both sides, the preservation of whales as part of the marine fauna, and the establishment of the whaling industry on a sound and permanent basis.

RESULTS of meteorological observations made at the Radcliffe Observatory, Oxford, under the direction of Dr. A. A. Rambaut, are published by order of the Radcliffe Trustees for the five years 1916–20. The volume contains daily observations of barometer, air, and evaporation temperatures, solar and terrestrial radiation temperatures, wind direction and velocity, cloud, hours of bright sunshine, and rainfall. Observations of ozone are given twice daily, and there is a summary of the weather and remarkable phenomena. In addition to these daily observations, mean monthly readings of the barometer are given for each of the five years, and for comparison the monthly means for sixty-six years, and similar means of the dry- and wet-bulb thermometers. The highest and lowest air temperatures are also given for the separate months and the monthly amounts of rain, with the means for seventy years, together with similar means of the amount of cloud, bright sunshine, and ozone. The mean amounts of ozone for the several months of the five years 1916–20 are so decidedly higher than the mean for the fifty-four years that it almost suggests that some difference may have occurred in the basis of registration. The lowest temperatures on the grass are tabulated for each month for the sixty years from 1861 to 1920, and the monthly maximum and minimum temperatures for each month in the last seventy years, with the monthly duration of sunshine for each of the last forty years. A diagram is given showing the triennial variation of the velocity of the wind, barometric pressure, and rainfall at Oxford for the years 1859–1920. Such details as those contained in the volume add much to our knowledge of the world's meteorology.

THE Geological Survey of the Union of South Africa has issued Memoir No. 16, which contains a description of the Mutue Fides-Stavoren Tinfields by Dr. Percy A. Wagner. This name has been given to what appears to be one of the most important portions of the O ifants River Tinfields, and the report contains a description of the deposits, their mineralogy, mode of occurrence, etc. The author appears to have come to the conclusion that this field is never likely to play any really important part in the tin production of the world, or even to equal some of the other tinfields of South Africa, but that, nevertheless, it is likely for a considerable time to come to produce moderate quantities of tinstone as well as ores of tungsten and copper.

THE September issue of the *American Journal of Science* contains a paper by Mr. W. D. Lambert, of the United States Coast and Geodetic Survey, in which some of the consequences of the rotation of the earth are pointed out in a way which will be much appreciated by readers not familiar with the mathematical developments of geodesy. The surface of the ocean is not strictly spheroidal, but is rather the rounding down towards a spherical form of a lens-shaped surface with its diameter one and a half times its thickness. If an elongated body of slightly less density than the ocean floats on the ocean, the forces on it tend to make it move towards the equator and set itself with its length along the meridian in latitudes greater than 45°, and at right angles to the meridian in latitudes less than 45°. The motion of the rod of an Eötvös balance tending to set in the prime vertical is also explained, and the possibilities which the modified balance opens up of detecting and studying local irregularities in the distribution of matter near the earth's surface are clearly pointed out.

IT is now well recognised that cod-liver and other fish oils are exceptionally rich in the vitamin-A which promotes growth. So far as is known at present, the only phase in the cycle of living organisms at which this substance is synthesised is that associated with the development of chlorophyll in plants. There is direct evidence that mammals cannot make it, and there is no evidence that any other animals can, though our information on this latter point is very scanty. In an interesting paper (*Biochemical Journal*, vol. 15, p. 530) which opens up a number of problems in the general biology of the growth-substance, K. H. Coward and J. C. Drummond raise the question as to where the fish get their store of vitamin from. They show by appropriate feeding experiments that green seaweeds contain a good deal, and they suggest that these form the ultimate source of the virtues of cod-liver oil, the cod obtaining them through the smaller animals on which it feeds by an unknown number of links, the last of which feeds on the seaweed. Attractive as it is at first sight, it may be doubted whether this explanation is quantitatively sound; the amount of seaweed in the sea is relatively very small, and it is indeed only a small fraction of even shallow waters that have a substantial growth on the bottom. It would be interesting to know the vitaminic relations of the plankton and some of the marine invertebrates.

A WORK that should be of scientific and economic importance is included in the list of announcements of the Oxford University Press, viz. :—"Ocean Research and the Great Fisheries," by G. C. L. Howell. Among the subjects dealt with are the great fisheries, the organisation of ocean research, the plaice question, the turbot and turbot culture, the soles, the haddock problem, Norwegian haddock investigation, the cod, the coalfish or saithe, the halibut, the hake fisheries, business men on hake problems, Dr. le Danois on the hake, the skates and rays, the ling, the whiting, and lemon soles. Another book appealing to readers of NATURE is "The Life and Scientific Correspondence of James Stirling," by C. Tweedie.

MESSRS. L. OERTLING, LTD., Turnmill Street, London, E.C.1, inform us that Sir Ernest Shackleton has taken an Oertling balance with him on the *Quest*. An Oertling balance was also taken by Admiral Sir George Nares on his expedition in 1873, and the same balance was used by the late Capt. Scott in his expedition in 1901, and during the war it was used in the Science Museum at South Kensington. It speaks well for the trustworthiness of an instrument which can be of service fifty years after the date of its manufacture.

MESSRS. GEORGE BELL AND SONS, LTD., announce for early publication a revised and enlarged edition of Madison Grant's "The Passing of the Great Race; or, the Racial Basis of European History," the first edition of which work was reviewed in NATURE of August 23, 1917 (p. 502). The new edition will contain a supplement of more than 100 pages, giving references to and quotations from authorities upon the subject treated of by the author.

THE firm of Mr. George Ellison, of Perry Parr, Birmingham, has prepared a number of lantern-slides illustrating various types of electric control gear such as oil rotor starters, switchboards, circuit-breakers, etc.; there are also some views of works. These slides will be loaned to engineering and technical societies and technical colleges upon application being made to the firm at the above address.

WE have received from Messrs. Reynolds and Branson, Ltd. (13 Briggate, Leeds) their catalogue of first-aid requisites. It includes a series of specially designed cases containing sterilised dressings and other requisites to meet the requirements of Home Office Orders as applied to factories and works.

THE latest catalogue (No. 419) of Mr. F. Edwards, 83 High Street, Marylebone, W.1, contains particulars of some 500 works dealing with Central and South America. It will doubtless be of service to those taking an interest in the history and exploration of the regions referred to.

Our Astronomical Column.

ANTARES AND ITS COMPANION.—Mr. F. G. Pease has measured the diameter of this star by the interferometer method at Mount Wilson. He obtains the result 0·040″, nearly the same as that for Betelgeuse. The parallax is uncertain, but it is believed to be about 0·009″, which makes the linear diameter 400,000,000 miles. W. S. Adams and A. H. Joy have succeeded in photographing the spectrum of the companion, at the Cassegrain focus of the 100-inch. It is of early helium type B 3, the H and K lines of calcium being fairly sharp, the other lines wide and hazy. Adams and Joy give −2·7 as the absolute magnitude of the primary, which gives +3·2 for the companion. This is unusually faint for a B-type star. The companion is 3·2″ distant, and the common proper motion indicates physical connection. There is no distinct evidence of orbital motion in seventy years.

THE BRIGHT OBJECT NEAR THE SUN.—Dr. W. Bell Dawson writes from Ottawa stating that he saw a bright object low in the west in unusually clear air just after sunset on September 4, which he assumes to be the same as that observed at Mount Hamilton on August 7. The identity seems unlikely; Dr. Dawson's object may have been Mercury (R.A. 11h. 36m.: N. Decl. 3° 38′), or Jupiter (R.A. 11h. 45m.: N. Decl. 2° 48′; the Sun was in R.A. 10h. 53m.: N. Decl. 7° 6′). However, it is well to put the observation on record, the mystery of the Mount Hamilton object being still unsolved.

STUDIES OF NEBULÆ AND CLUSTERS.—M. Camille Flammarion has in recent months contributed a series of illustrated articles on this subject to *L'Astronomie*. The September issue deals with the interesting nebula N.G.C. 4594 in Virgo, the discovery of which is usually attributed to Sir W. Herschel in 1784. M. Flammarion has, however, discovered a manuscript note in Messier's handwriting, showing that his assistant Méchain found it on May 11, 1781. It is suggested that it should be called Messier 104.

It belongs to the class known as spindle nebulæ; they are of regular outline, long and narrow; the width is greatest in the centre, and tapers nearly to a point at each end. Two drawings and two photographs of the nebula are reproduced, the former by Sir J. Herschel and Lassell, the latter by Dr. Isaac Roberts and Mr. F. G. Pease. All four are in good accord, but the photographs show considerably greater width in the centre. Many of the spindle nebulæ, including this one, have a dark central strip, with nearly parallel edges, dividing them longitudinally into two parts. It seems scarcely possible dynamically that this should be a real division, and it is generally assumed that there is an equatorial zone of dark occulting matter encompassing the nebula.

It is believed that the spindles are spirals seen edgewise, in which case they are important as affording a knowledge of the cross-section of the latter; the thickness in the central regions is one-third or one-fourth of the equatorial diameter; this is much the same proportion as that assigned by star-gauges to our own stellar system. This is one of the arguments used in support of the view that the spirals are external galaxies. It has further been suggested that the galaxy may have an outer belt of absorbing matter, like that seen in the spindle nebulæ, which would explain the absence of spiral nebulæ in the galactic neighbourhood.

Sir J. Herschel erroneously gave the position angle of the nebula M. 104 as 102°. The photographs give 80°; there has been no real change, since Smyth in 1837 and Lassell in 1862 both noted it as parallel to the equator.

International Meteorological Committee.

THE first meeting, for general purposes, of the International Committee appointed by the Conference of Directors of Meteorological Institutes and Observatories held in Paris in 1919, in continuation of the committees which have organised international meteorology from the Congress of Vienna in 1873, was held during the week September 12–17 in London. Those attending as members were Sir Napier Shaw (president), M. A. Angot (vice-president), Prof. E. van Everdingen (secretary), Col. F. A. Chaves, Director Hesselberg, Comdt. Jaumotte, Dr. Maurer, and Capt. Ryder; as presidents of commissions, Prof. Bjerknes (Bergen), of the Commission for the Study of the Upper Air; Col. E. Gold, of the Commission for Weather Telegraphy; and Col. Saconney, of the Commission for Aerial Navigation; and, as savants whose assistance would be useful in the deliberations of the committee, Col. Delcambre, Dr. Gorczynski, Col. Matteuzzi, Dr. Melander, Prof. T. Okada, Dr. G. C. Simpson, Dr. A. Wallén, Dr. S. Fujiwhara, and Mr. L. F. Richardson.

The business opened with the election of two members of the committee—Director Wallén, of Sweden, to fill the sixteenth place, which was left vacant at Paris, and Prof. T. Okada, of Tokyo, in succession to Prof. Nakamura, of the same institute, resigned. It concluded with the election of Col. Delcambre, Director of the Office Météorologique National of France, and Dr. G. C. Simpson, Director of the Meteorological Office, London, to the places vacated at the end of the meeting by M. Alfred Angot, Directeur honoraire du Bureau Central Météorologique, and by Sir Napier Shaw, now professor of meteorology in the Royal College of Science, under the rule which requires the sixteen (ultimately twenty) members of the committee to belong to different countries and to be directors of independent meteorological institutions.

Apologies for absence were received from Prof. Eginitis, of Athens; Mr. H. A. Hunt, of Melbourne; Prof. Nakamura, of Tokyo; Prof. Palazzo, of Rome; Sir Frederick Stupart, of Toronto; and Dr. G. T. Walker, of Simla.

The chief business of the meeting was to receive reports from the commissions for special departments of meteorological work. Of these, two—namely, the Commission for the Study of the Upper Air and the Commission for the Meteorology of the Polar Regions—had met in Bergen in the last week of July of this year. The Commission for Weather Telegraphy had held a meeting in London in November of last year to formulate new codes for the transmission of information, from land stations and from ships respectively, in pursuance of certain provisions of the Peace Treaty. That commission held further meetings in the week ending September 10 of this year for the discussion of details in the light of experience already obtained. In the same week meetings were held of the Commission for Maritime Meteorology, for Aerial Navigation, and a joint meeting of the three commissions concerned with the speedy transmission of meteorological information was held to consider points of common interest. Meetings of the Commission for Réseau Mondial were also held.

The chief recommendations discussed were:—(1) By the Commission for the Study of the Upper Air, inviting observations of the upper air from land and sea and proposing to resuscitate the practice of preparing and issuing an international publication of the results for the upper air contributed by the various countries, and to obtain subventions for the purpose of providing for the cost of compilation and editing, as well as of printing and distributing. The total annual sum required was estimated at 4000*l.* sterling. (2) By the Commission for Weather Telegraphy, setting out an agreed code for land stations and, jointly with the Commissions for Maritime Meteorology and Aerial Navigation, two alternative codes for ships at sea, between which a selection should be ultimately made so that one form of message shall become universal. (3) By the Commission for Maritime Meteorology, proposing suitable co-operation for the collection of oceanographical data. The formulation of the codes and the approach to a final solution of the questions involved are a matter for warm congratulation.

The Commission for the Réseau Mondial recorded its thanks for the volumes which the British Meteorological Office had already published, and expressed a desire for their continuance. At the same time the question of daily charts for the globe was raised, and Col. Matteuzzi urged the daily issue of reports of pilot-balloons with the object of obtaining a general view of the streams of air.

On the initiative of Col. Delcambre, a new commission was set up for the further study of clouds; and on the initiative of Col. Saconney it was recommended that rewards should be offered for valuable observations, notes, or photographs spontaneously contributed by aviators and others.

Prof. Okada, on behalf of Prof. Nakamura, urged the industrial and economic, as well as the scientific, importance of a speedy publication by all institutes of a summary of the weather month by month.

Some time was devoted to the question of the application of meteorology to agriculture, and the commission appointed at Paris for that study was enlarged by the addition of a number of names of experts on the agricultural or biological side of the various subjects involved. It was also decided that application of the study of weather to forestry should be included.

The report of the Polar Commission dealt with the provision that had been made at Obispo, Spitsbergen, Bear Island, Jan Mayen, Lerwick, and in northern Canada and elsewhere, for geophysical investigations during Amundsen's proposed drift across the Pole. It was decided to unite the Polar Commission with the Commission du Réseau Mondial. Dr. Simpson was appointed president of the united commission.

At the meeting on September 15 Col. F. A. Chaves, of the Azores, well known to all meteorologists for his enthusiasm for the subject, announced that the Portuguese Government had appointed Sir Napier Shaw, M. Angot, and Prof. E. van Everdingen to the dignity of Commander of the Order of Santiago da Espada in recognition of their services to international meteorology, and that he expected to be able to present the insignia on behalf of his Government before the close of the meeting.

When the general business of the meeting was concluded, and after the completion of the number of sixteen members, it became necessary to hold a meeting of the reconstituted committee in order to make appointments to the presidency and vice-presidency, which had become vacant by the retirement of Sir Napier Shaw and M. Angot. By a unanimous vote of the committee Sir Napier Shaw was invited, and consented, to act as president until the conference in 1923. Prof. E. van Everdingen was elected vice-president, and Dr. Hesselberg, Director of the Meteorological Institute, Christiania, secretary.

It was agreed, on the invitation of Prof. E. van

Everdingen, that a conference of directors of meteorological institutes and observatories should be held at Utrecht in 1923, either in the spring or autumn as may be found the more convenient.

The meetings of the committee were held in the library of the Meteorological Office, South Kensington, and those of the commissions in the council-room of the Air Ministry in Kingsway.

Dr. and Mrs. Simpson received the visitors at the Meteorological Office, South Kensington, on the evening of Wednesday, September 7. The Government entertained them on September 9 at a luncheon, at which Sir Frederick Sykes, Controller-General of Civil Aviation, welcomed them. Capt. C. J. P. Cave, of Stoner Hill, Petersfield, gave a luncheon in their honour on September 15, and the evening of September 16 was devoted to a dinner given by the president.

The International Illumination Commission.

THE first technical session of the International Illumination Commission was held in Paris on July 4–8, many delegates from the chief countries of Europe and the United States being present. The proceedings were opened by the Minister of Public Works in the name of the French Republic.

Dr. E. P. Hyde (U.S.A.) was elected president for the forthcoming period, M. Th. Vautier being nominated an honorary president in recognition of his past work on behalf of the Commission; and Mr. C. C. Paterson was elected hon. secretary. After the conclusion of formal business international technical committees were nominated to deal with the subjects of nomenclature and symbols, heterochromatic photometry, factory and school lighting, and automobile headlights. The unit of candle-power at present in use in this country, in France, and in the United States was adopted for international purposes, and is to be known as the "international candle." It is maintained by means of electric incandescent lamps at the national laboratories of the three countries named. Definitions of various photometric quantities, such as luminous flux, illumination, and luminous intensity, were also adopted.

Reports dealing with nomenclature and symbols were presented by a sub-committee of the British National Illumination Committee, by the Illuminating Engineering Society in the United States, and by Prof. A. Blondel, some differences in procedure being evident. These matters will doubtless be dealt with by the international technical committee referred to above. A paper by Mr. E. C. Crittenden referred to the growing recognition of the desirability of a primary standard based on the luminous radiation from a surface under specified conditions, in preference to the construction of certain types of lamps. Recent researches on the light yielded by a black body at a prescribed temperature have led to promising results; for example, it appears that such a body at 2077° K. emits 70·2 candles per sq. cm. Confirmatory researches are, however, needed. Papers by Mr. L. Gaster, Mr. L. B. Marks, and others dealt with industrial lighting, special reference being made to the question of legislation, as exemplified in the codes of some American States. While there was a recognition that the time is ripe for statutory provisions requiring adequate and suitable lighting in general terms, it was felt that it would be premature to attempt to frame a detailed series of requirements as a basis for legal procedure. Ultimately, however, an "international code" of factory lighting may be realised. Other papers dealt with motor-headlight regulations, which, like the preceding subject, was referred to a committee; and there were a number of contributions summarising recent progress in heterochromatic and physical photometry. Of special interest was a paper by Dr. E. P. Hyde, giving results for the mechanical equivalent of light, the most recent determination being in the neighbourhood of 0·00150 watts per lumen.

It was provisionally arranged that the next meeting should take place in the United States in 1924.

University and Educational Intelligence.

BIRMINGHAM.—On the recommendation of the Senate, a University Research Committee has been appointed. This committee consists of fifteen members, viz. the Vice-Chancellor, the Principal, and five other members elected by the Council of the University, together with eight members of the Senate, elected on the nomination of the faculties as follows: three from the Faculty of Science, two each from the Faculties of Arts and Medicine, and one from the Faculty of Commerce. These members are appointed in the first place for two years, and are eligible for reappointment at the end of that period. The object of the committee is "to facilitate by all means in its power the prosecution and publication of original research in all branches of knowledge." The members appointed by the Council are Sir Richard Threlfall, Messrs. T. S. Walker, W. Waters Butler, Hugh Morton, and William Tangye; and the Faculty of Science is represented by Profs. F. W. Burstall, F. W. Gamble, and S. W. J. Smith. The Registrar is to act as secretary.

The Durham Coal Owners' Association has announced that the Northumberland Coal Owners' Association is prepared to recommend its members to join with those of the former association in contributing a total sum of 500*l.* per annum for a period not exceeding three years to the Mining Research Laboratory of the University of Birmingham, unless the fund constituted under the Mining Industry Act should be drawn upon for this purpose.

Mr. L. Eastham has been appointed lecturer in zoology, and Miss Laura M. Ligertwood lecturer in physiology (to succeed Dr. Frost).

CAMBRIDGE.—Messrs. A. B. Appleton, Downing College, D. G. Reid, Trinity College, A. Hopkinson, Emmanuel College, and V. C. Pennell, Pembroke College, have been reappointed demonstrators in anatomy. Mr. E. W. Hulme has been elected to the Sandars readership in bibliography and palæography for the year 1921.

The address of the retiring Vice-Chancellor, Dr. P. Giles, master of Emmanuel College, refers to many interesting points. On extensions and new buildings more than 130,000*l.* was spent in the last year. The greater portion of the money was for chemistry, biochemistry, parasitology and the low temperature station, and was provided from special endowments. But more money is still required to meet the expenses incurred in the new engineering school. It may be of interest to other institutions to note that the University has now to provide more than 10,000*l.* in local rates for the present year. Fear was expressed by the Vice-Chancellor that increased cost of maintenance might compel the University to make a small charge for admission to the Fitzwilliam Museum and the Botanic Garden. Reference was made to the increase in the number of research students, and to a beginning made in the exchange of teachers between universities. The new Vice-Chancellor is Dr. E. C. Pearce, master of Corpus Christi College.

The vote on the admission of women to the University will take place on October 20. This is presum-

ably the last opportunity that the University will have of settling the problem for itself.

LONDON.—The following are some of the public lectures to be given at University College during the Michaelmas term:—Three lectures on "Babylonian Magic," by Dr. T. G. Pinches; a course of lectures on "Einstein's Theory of Relativity," by Dr. G. B. Jeffery; one lecture on "The Philosophical Aspects of the Theory of Relativity," by Prof. G. Dawes Hicks; eight on "Nutrition," by Dr. J. C. Drummond; three on "Nature in the 'Divina Comedia'"; one on "Recent Researches in Photo-Elasticity," by Prof. E. G. Coker; and a course of lectures on "The Evolution of Man," by Prof. G. Elliot Smith. A full list of the lectures may be obtained by sending a stamped addressed envelope to the Secretary, University College, London, W.C.1.

Eleven separate courses of lectures on the history of science will be delivered at University College during the session 1921–22. There will be a course on "The General History and Development of Science," by Dr. A. Wolf, and one on "The Beginnings of Science," by Prof. Elliot Smith. In addition, there will be courses on the history of particular departments of science, namely, Astronomy, Prof. Filon; Physics, Sir William Bragg and Mr. Orson Wood; Chemistry, Prof. Donnan; The Alchemical Period, Prof. Collie; From Mayow and Boyle to Dalton and Avogadro, and the Development of the Molecular Theory, Dr. Irvine Masson; The Development of Organic Chemistry in the Nineteenth Century, Dr. O. L. Brady; The Development of Physical Chemistry in the Nineteenth Century, Mr. W. E. Garner; and The Biological and Medical Sciences, Dr. C. Singer.

A course of public lectures on "Psychology and Psychotherapy" will be delivered at King's College, Strand, W.C., on Tuesdays at 5.30 p.m., beginning October 18, by Dr. William Brown, Wilde reader in mental philosophy in the University of Oxford. Admission is free without ticket.

FOUR lectures by Dr. F. W. Aston on atomic weights and isotopes will be delivered at 5.45 p.m. on successive Wednesdays, commencing October 12, at Battersea Polytechnic, S.W.11. This is the first occasion on which a course of lectures dealing with this topic has been given in London.

A LECTURE on "The Geology of Petroleum" will be delivered at the Sir John Cass Technical Institute, Jewry Street, Aldgate, E.C., by Mr. E. H. Cuningham Craig on Monday, October 10, at 7 p.m. The lecture, at which Sir Frederick Black will preside, will form an introduction to the course of petroleum technology which the institute is offering this year for the first time.

THE Universities' Library for Central Europe has now been in existence for a little more than a year, and a report has been issued giving an account of its activities up to March 31 last. Up to that date more than 2000 works had been despatched to various centres in Europe for distribution to universities, and, in addition, large numbers of scientific reviews and periodicals and the journals and transactions of learned societies had been forwarded. Something substantial has, therefore, been done to replenish the stocks of English literature in the universities and libraries of Central Europe. The library has also been able, as a result of correspondence with the Conjoint Board of Scientific Societies, to put many of the Continental universities in touch again with British scientific societies with the view of exchanging publications, and by an appeal to a number of scientific journals reduced subscription rates have in many cases been secured. Although much valuable assistance has been rendered in this way, the response made to the appeal for books, publications, and subscriptions has not been sufficient to enable the library to cope with the very real dearth of scientific works from which European universities are suffering. Further donations of books and money are therefore solicited, and gifts should be forwarded to the hon. secretary, Mr. B. M. Headicar, London School of Economics, Clare Market, London, W.C.2.

THE calendar of the North of Scotland College of Agriculture for 1921–22 may be divided conveniently into two portions, one dealing with the facilities for instruction which will be available in the coming session, and the other with the extra-mural work carried out by the college. The courses of study vary in length. Three-year courses are arranged for students preparing for the B.Sc. in agriculture and in forestry, as well as for the National Diplomas in Agriculture and Dairying awarded jointly by the Royal Agricultural Society of England and the Highland and Agricultural Society of Scotland; two-year courses lead to diplomas in agriculture and forestry awarded by the University of Aberdeen; and there is a special one-year course in preparation for the college Planter's Certificate. Two courses of evening lectures on horticulture and manures respectively have also been arranged. Important research work is being carried out in conjunction with Aberdeen University at the Rowett Institute for Research in Animal Nutrition. Extra-mural work of the college staff affects the whole of the North of Scotland and the adjacent islands. Advice on farm management, plant diseases, insect pests, and seed-testing is given, and under the direction of county organisers lectures and instruction in agriculture, horticulture, dairying, poultry keeping, etc., are given at recognised centres.

THE Cleveland Technical Institute, Middlesbrough, was formally declared open by Sir Charles A. Parsons on September 22. The institute, which is the outcome of joint action by the Cleveland Institution of Engineers and the North-East Coast Institution of Engineers and Shipbuilders, has been established with the object of providing facilities for engineers, shipbuilders and metallurgical chemists desirous of becoming thoroughly conversant with new developments in their own and cognate subjects. Membership will be limited to members of the societies which have founded the institute, together with the members of local technical societies, and the government will be in the hands of a council constituted from representatives of the various participating societies and donors under the chairmanship of Dr. J. E. Stead. It is hoped that the institute may encourage the continued technical education of employées in industrial works in the Tees-side districts, and to further this object lectures to workmen on subjects relating to local industries will be arranged; improvements in processes and designs will be investigated, and also a bulletin of abstracts from current scientific papers will be published monthly. In declaring the institute open, Sir Charles Parsons emphasised the importance of technological training for maintaining our industries, and congratulated Dr. Stead and the council on organising successfully an institution which would be open to members of all the technical societies, engineering, chemical, and metallurgical, established in the neighbourhood. This scheme, though it has been advocated widely, has never before been put into effect in this country, but where it has been adopted the results have been eminently satisfactory.

Calendar of Scientific Pioneers.

October 6, 1825. Bernard Germain Etienne de la Ville, Comte de Lacépède, died.—The disciple and friend of Buffon, Lacépède, after the Revolution, was appointed to a chair of zoology in the Jardin des Plantes, and published various works on natural history.

October 6, 1880. Benjamin Peirce died.—A leader in the American world of science, Peirce was professor of astronomy and mathematics at Harvard, and for some time superintendent of the U.S. Coast Survey. He wrote many treatises, and was a founder of the American Academy of Sciences.

October 6, 1894. Nathanael Pringsheim died.—The founder in 1858 of the Jahrbuch für Wissenschaftliche Botanik, and in 1882 of the German Botanical Society, Pringsheim contributed much to the study of sex in plants, of algæ, and of alternations of generations.

October 6, 1902. John Hall Gladstone died.—Following in the footsteps of Graham, Gladstone devoted himself mainly to physical chemistry, and especially studied the relation of the elements and compounds to light. Of independent means, he gave much time to educational and social matters He was the first president of the Physical Society.

October 6, 1911. John Hughlings Jackson died.—Physician to the London Hospital and the Hospital for Epileptics, Jackson was one of the first in England to use the ophthalmoscope, and was distinguished by his work on the nervous system and epilepsy.

October 7, 1847. Alexandre Brongniart died.—A famous mineralogist and the associate of Cuvier, Brongniart, after serving in the army, became director of the Sèvres porcelain factory, and in 1822 succeeded Haüy at the École des Mines.

October 8, 1647. Christian Severinus Longomontanus died.—An assistant to Tycho Brahe at Hven, Longomontanus, or Longberg, accompanied Tycho to Bavaria, and from 1605 onwards was professor of mathematics at Copenhagen. His "Astronomica Danica," 1622, is an exposition of the Tychonic system of the world.

October 9, 1869. Otto Linné Erdmann died.—For nearly forty years professor of technical chemistry at Leipzig, Erdmann made valuable researches on nickel and on indigo and other dyes, and with Marchand made determinations of atomic weight.

October 10, 1679. John Mayow was buried.—Remembered for his advanced views on combustion and respiration, Mayow, who was a physician, died in London in September, 1679, and was buried on October 10 in St. Paul's, Covent Garden. It has been said that his premature death retarded the advance of modern chemistry by a century.

October 10, 1708. David Gregory died.—Nephew to James Gregory, the inventor of the reflecting telescope, David Gregory owed his fame to his advocacy of the Newtonian philosophy, which he was the first publicly to teach. From 1691 he was Savilian professor of astronomy at Oxford.

October 11, 1708. Ehrenfried Walter Graf von Tschirnhausen died.—A mathematician, Tschirnhausen was the founder of catacaustics, and was known as the maker of large burning glasses.

October 11, 1889. James Prescott Joule died.—The favourite pupil of Dalton, and one of the most intimate friends of Kelvin, with whom he collaborated, Joule is universally known for his determination of the mechanical equivalent of heat, and for his share in establishing the law of the conservation of energy. His epoch-making papers were read in 1843, 1845, 1847, and 1849. The Copley medal was awarded to him in 1870. E. C. S.

Societies and Academies.

BIRMINGHAM.

Institute of Metals.—Annual autumn meeting, September 21.—Prof. A. A. **Read** and R. H. **Greaves**: The properties of some nickel-aluminium-copper alloys. In some of the copper-rich nickel-aluminium-copper alloys the α-solution will retain more nickel and aluminium at 900° C. than at the ordinary temperature. These alloys, while relatively soft on quenching from 900° C., are hardened by slow cooling or by reheating to lower temperatures. This change is the result of the appearance of a new constituent, probably a nickel-aluminium-copper solid solution, the separation of which is accompanied by changes in density and electrical conductivity, in addition to its effect on tensile, hardness, notched bar, and other tests. The separation of this special constituent takes place slowly, so that chill-cast alloys and hot-rolled rods of small section consist almost wholly of the α-constituent. On annealing the cold-rolled alloys softening proceeds slowly up to 500° C., when precipitation of the nickel-aluminium-rich constituent begins to take place. If the separation is sufficient, this may give an alloy of high elastic limit and tensile strength and good elongation. The hardest product is obtained by reheating the quenched alloy for some time at 600–700° C. Alloys so treated generally give better properties than those obtained by uniform rates of slow cooling, and show considerable endurance under alternating stresses above their true fatigue limit.—R. T. **Rolfe**: The effect of increasing proportions of lead upon the properties of Admiralty gunmetal, with an appendix dealing with the effect of lead on gunmetal containing copper 85 per cent., tin 5 per cent., and zinc 10 per cent. Synthetic alloys containing increasing proportions of lead up to 1·68 per cent. were examined. In sand-cast gunmetal lead gradually increases the strength, ductility, and softness of the alloy up to about 1·5 per cent. of lead, but above this proportion causes a decrease in all three. It does not affect the soundness. In chill-cast gunmetal the effect on the hardness parallels that of the sand-cast metal, with a change-point at about 1·5 per cent. of lead, but associated with a minimum rather than a maximum strength figure. It does not affect the soundness. The influence of lead on liquation, machinability, corrosion, and behaviour for bearing purposes is discussed, and it is suggested that in sand-cast gunmetal the proportion of lead permitted by the Admiralty specification might with advantage be increased from 0·5 to 1 per cent.—R. **Genders**: The casting of brass ingots. The failure of hollow-drawn articles made from brass rod has generally been found to be due to the presence of non-metallic inclusions which originated in the cast ingot. The methods used in casting ingots of brass vary, much consideration being given to the saving of rolling. When a hollow article subject to expanding stresses is to be made, the avoidance of inclusions of foreign matter is vital, and the form of ingot requires modification. The ingots made were 3 in. square and 30 in. in length, as compared with the ingots 6–7 ft. in length and 1½ in. square section in common use. A hot sinking head or "dozzle" was introduced, and molten brass is poured through the "dozzle." No pipe is formed in the ingot proper, and additions of metal may be made at any time to the metal in the "dozzle" without risk of introducing defects into the ingot, any dross rising to the top of the still fluid head. The moulds were tapered, the top being enlarged by increasing amounts in successive experiments, and ingots were cast at the usual foundry speed.—T. G. **Bamford**: The density

of the zinc-copper alloys. Experiments were conducted with alloys made from pure metals and cast in sand- and chill-moulds respectively. There is a contraction in volume due to alloying with mixtures containing more than 25 per cent. of copper, and the density of the sand-cast or slowly cooled alloys is generally less than that of the chill castings; at points where the liquidus and solidus coincide on the constitutional diagram, chill castings and sand castings give the same values. The expansion recorded by Turner and Murray with alloys containing less than 30 per cent. of copper is confirmed, and is shown to be connected with a new form of porosity different from ordinary unsoundness.—Dr. F. **Johnson**: Experiments in the working and annealing of copper. Part 1: Critical ranges of deformation probably result from stages of abnormal plasticity during rolling of the metal. It is suggested that during these stages the metal actually loses some of the increase of hardness conferred in earlier "passes." A decrease of volume up to 85 per cent. occurs; the increase of volume which then sets in may correspond to the inception of permanent disability which cannot be eradicated by annealing. Part 2: At 200° C. for one hour softening occurs in all strips rolled beyond 40 per cent. reduction. Test-pieces from the axes of the strips undergo softening to a greater extent than edge-specimens from the same series when annealed under the same conditions, thus indicating a greater intensity of strain at the centre than at the edges. High-temperature annealing at 750° C. shows that at 87 per cent. reduction a rapid decrease in strength sets in. Part 3: Low-temperature annealing of cold-drawn copper rods of varying compositions. "Tough-pitch" arsenical rods retain their strength practically unimpaired up to 300° C., whereas "tough-pitch" electrolytic copper undergoes considerable loss of strength. The presence of silver in arsenical rods raises slightly the annealing temperature. The substitution of iron for oxygen in arsenical copper retards the rate of softening.—W. E. **Alkins** and W. **Cartwright**: The effect of progressive cold-drawing upon some of the physical properties of low-tin bronze. The tin content varied from about 0·7 to about 1·0 per cent. in the three samples of bronze studied. The most important and rapid changes in properties occur after a reduction of 85 per cent. of the original area, *i.e.* over the range where practical difficulties are met with during drawing. The extent of the variation in tensile strength, specific volume, and scleroscope hardness is very similar to that previously found in the case of copper.

September 22.—R. **Genders**: The extrusion defect. Experiments have been carried out with the object of devising a method of extrusion which would avoid the formation of the defect known as "piping," which is commonly found in some centrally extruded rod made from brass and other non-ferrous alloys by the usual hot-extrusion process. The defect is tubular in the interior of the rod, and generally exists in the last portion extruded. When a defective rod is broken across, the core frequently breaks at a different point from the outer ring. The defect consists of foreign matter, oxide and dezincified brass, which constituted the skin of the original billet. Billets extruded to various stages and sectioned axially show the presence of the defect in the shape of a funnel. The defect can be largely overcome by the use of a ram smaller in diameter than the billet, which causes the outer layer of the billet to remain in the receiver as a thin cylinder, but the method would probably be too wasteful on a large scale. By inverting the process so that the die is pushed through the billet the mode of flow is altered. There is no relative movement between the billet and receiver, and flow is confined to the region of the die. The power required is less than with the method at present in use. The method is in use in many places for the production of tubes and rod from soft metals.—F. S. **Tritton**: The use of the scleroscope on light specimens of metals. Errors were detected when using the ordinary methods of support, and to reduce them pitch and glucose were selected. The use of pitch requires a special clamp, a new type of which is described. A solution of glucose considerably stiffer than treacle gave good results, the specimens being attached by means of the glucose to a hard steel base. The hardness of specimens having both flat and curved surfaces can be tested provided that a recessed support be made to fit the specimens.—D. H. **Ingall**: The relation between mechanical properties and microstructure in pure rolled zinc. The material as rolled, and also when annealed, at 100° and 150° C., is ductile "with" and brittle "across" the direction of rolling, with reduction from 77 to about 87 per cent.; it is ductile in all directions with 96 per cent. reduction by rolling, where the strength has risen from about 6 to about 13 tons per sq. in. An equi-axed structure exists in all cases. Annealing for thirty minutes at 200° C. renders the material completely brittle and weak, due to a crystallisation.—Dr. D. **Hanson** and Marie L. V. **Gayler**: The constitution and age-hardening of the alloys of aluminium with magnesium and silicon. The ternary system aluminium, magnesium, and silicon, containing up to 35 per cent. of magnesium and 11 per cent. of silicon, has been investigated. Thermal curves and microscopic examination prove that magnesium and silicon form a chemical compound having the formula Mg_2Si, which with aluminium forms a eutectiferous binary system, having an eutectic containing 13 per cent. of Mg_2Si, and melting at 590° C. The aluminium–Mg_2Si–silicon system possesses a ternary eutectic that melts at 550° C.; the ternary eutectic of the aluminium–Mg_2Si–magnesium system melts at 450° C. The solubility of Mg_2Si in solid aluminium is 1·6 per cent. of Mg_2Si at 580° C. and about 0·5 per cent. at 30° C. Excess of silicon has little effect, but magnesium reduces the solubility at high temperatures. The difference in the solubility of Mg_2Si at high and low temperatures is the cause of the age-hardening property of these alloys, which in a series of alloys containing increasing amounts of Mg_2Si rises progressively until the limit of the solubility of Mg_2Si in aluminium at the quenching temperature is reached, beyond which the total increase in hardness remains constant. The increase in hardness is roughly proportional to the amount of Mg_2Si retained in solution by quenching.—F. **Adcock**: The electrolytic etching of metals. A solution of citric acid as an electrolyte in the etching bath gave good results with cupro-nickel (80 : 20), silver, nickel-silver, and some other metals. Certain specimens of silver showed on etching a cell-structure or network which was smaller than, and in some cases independent of, the existing crystal grains. Another electrolyte made by dissolving molybdic acid in excess of ammonia solution gave similar results, and revealed a subsidiary cell-formation or network in the β-regions of a $\beta+\gamma$ brass containing 6 per cent. of aluminium. By using hydrofluoric acid, chromic acid, and bromine water, both the cores and the crystal-grain boundaries of cast cupro-nickel were disclosed simultaneously.—S. **Beckinsale**: The magnesium alloy "electron." Samples of the new high magnesium alloy "electron" contained about 95 per cent. of magnesium, 4·5 per cent. of zinc, and 0·5 per cent. of copper. The alloys machined well,

and compared very favourably with aluminium alloys in tensile properties (allowance being made for the much lower specific gravity), but they were not so ductile in compression.

PARIS.

Academy of Sciences, September 19.—M. Georges Lemoine in the chair.—The President announced the death of Alfred Grandidier, member of the section of Geography and Navigation.—J. **Kampé de Fériet**: Some properties of hypergeometrical functions of higher order with two variables.—MM. **Barbillion** and M. **Dugit**: A simple apparatus for obtaining the deviation of the edge of an aeroplane due to the effect of the wind.—M. **d'Azumbuja**: A method for the synchronisation of clock mechanism and of pendulums employed in astronomy. The clockwork mechanism generally used in observatories for controlling the motion of telescopes or mirrors do not possess the accuracy of astronomical clocks, and when used for long photographic exposures frequent rectifications by the observer are necessary. In the apparatus proposed by the author, which has been set up at Meudon, a weight-driven motor is controlled electrically by a pendulum. A diagram of the arrangement is given; it has been in use at Meudon for more than a year, and has proved satisfactory.—A. **Kozlowski**: The origin of the oleoleucites in the liverworts carrying leaves. The examination of living specimens of *Lophocolea heterophylla, L. bidentata, Lepidozia reptans,* and *Mastygobryum trilobatum* leads to the conclusion that Pfeffer's hypothesis on the formation of oleoleucites by the agglomeration of droplets is justified, in spite of the contrary opinions of Wakker, Raciborski, and Garjeanne.—M. **Romieu**: Morphology of the spermatozoid of Chætopterus.—M. **Bridel**: the action of emulsin from almonds on lactose in 85 per cent. ethyl alcohol. The reaction is a complex one: galactose and β-ethylgalactoside were isolated, the former in crystalline form.

SYDNEY.

Royal Society of New South Wales, August 3.—Mr. E. C. Andrews, president, in the chair.—R. H. **Cambage**: Acacia seedlings. A seed of *Acacia melanoxylon* from Jenolan Caves had germinated after having been immersed in sea-water for four years and one month. The rapid germination of *A. Oswaldi*, which grows in the dry interior, is noted. This character may have been developed through the habit of germination after thunderstorms, when the young plant has to establish itself before the succeeding dry weather overtakes it.—G. D. **Osborne**: A preliminary examination of the late Palæozoic folding in the Hunter River District, New South Wales. By the aid of a diagram, giving the elemental features of the diastrophism, it is shown that the earth's segment in the district has undergone a crustal shortening of 7·46 miles, the original width of 77·96 miles now being compressed into 70·50 miles. The depth of the earth block involved has been calculated, and the effects of the strike faulting, in relation to the determination of the vertical bulging resultant upon the thrusting, are discussed.—A. R. **Penfold**: Note on the position of the double linkage in piperitone. On oxidation with neutral potassium permanganate solution diosphenol in monoclinic needles of melting point 82° C. was obtained. This body possesses a well structure of which the double linkage is in the 1 position. Piperitone must therefore be Δ-1-menthone-3.—Dr. L. A. **Cotton**: Earth movements at Burrinjuck, as recorded by horizontal pendulum observations. Horizontal pendulums were installed to measure the movement of the rocks under the load of water impounded by the Burrinjuck Dam, and the relation between the movements of the pendulums and the temperature changes registered by a thermometer placed within the concrete dam, at a distance of 80 ft. from the surface, were investigated. The rock movements are seasonal in character, with a lag of several months, corresponding closely to the temperature lag. The actual movement is from five to ten seconds of arc, which is probably sufficient to cause considerable strain in the rock-masses involved.

Books Received.

The Rift Valleys and Geology of East Africa: An Account of the Origin and History of the Rift Valleys of East Africa and their Relation to the Contemporary Earth-Movements which Transformed the Geography of the World. By Prof. J. W. Gregory. Pp. 479. (London: Seeley, Service and Co., Ltd.) 32*s*. net.

Zoology for Medical Students. By Prof. J. Graham Kerr. Pp. x+485. (London: Macmillan and Co., Ltd.) 25*s*. net.

A Text-book of Qualitative Analysis of Inorganic Substances. By Dr. S. A. Kay. Pp. vii+80. (London: Gurney and Jackson; Edinburgh: Oliver and Boyd.) 7*s*. 6*d*. net.

The International Forestry Bibliography, including Allied Subjects. By Dr. A. H. Unwin. Pp. 48. (Critchmere, Haslemere: Forest Lover's Library.) 2*s*. 6*d*. net.

Wightman's Secondary Schools Mathematical Tables. Edited by F. Sandon. Pp. 96. (London: Wightman and Co., Ltd.) 6*d*.

The Depths of the Soul: Psycho-Analytical Studies. By Dr. William Stekel. Authorised translation by Dr. S. A. Tannenbaum. Pp. v+216. (London: Kegan Paul and Co., Ltd.) 6*s*. 6*d*. net.

An Introduction to Biophysics. By Dr. D. Burns. Pp. xiii+435. (London: J. and A. Churchill.) 21*s*. net.

Handbuch der Gesamten Augenheilkunde. Begründet von A. Graefe und Th. Saemisch. Fortgeführt von C. Hess. Herausgegeben von Th. Axenfeld und A. Elschnig. Dritte, neubearbeitete auflage. Die Brille als Optisches Instrument. Von Prof. Dr. M. von Rohr. Dritte auflage. Pp. xiv+254. (Berlin: J. Springer.) In Germany, 66 marks; in England, 132 marks.

The Chemistry of Colloids and some Technical Applications. By Dr. W. W. Taylor. Second edition. Pp. viii+332. (London: E. Arnold and Co.) 10*s*. 6*d*. net.

An Introduction to Projective Geometry. By Prof. L. N. G. Filon. Third edition. Pp. viii+253. (London: E. Arnold and Co.) 7*s*. 6*d*.

Forensic Chemistry. By A. Lucas. Pp. viii+268. (London: E. Arnold and Co.) 15*s*. net.

Organic Evolution: Outstanding Difficulties and Possible Explanations. By Major Leonard Darwin. Pp. viii+47. (Cambridge: At the University Press). 4*s*. net.

On some Antiquities in the Neighbourhood of Dunecht House, Aberdeenshire. By the Right Rev. Dr. G. F. Browne. Pp. xiv+170+63 plates. (Cambridge: At the University Press.) 63*s*. net.

A First Book of General Science: An Introduction to the Scientific Study of Animal and Plant Life. By A. T. Simmons and A. J. V. Gale. (First Books of Science series.) Pp. viii+145. (London: Macmillan and Co., Ltd.) 2*s*. 6*d*.

The Institution of Mechanical Engineers. Eleventh Report to the Alloys Research Committee. On Some Alloys of Aluminium (Light Alloys). By Dr. W.

Rosenhain, S. L. Archbutt and Dr. D. Hanson. Pp. ii+256+24 plates. (London: Institution of Mechanical Engineers.) 2*l*. 2*s*.

A Synopsis of the Accipitres (Diurnal Birds of Prey). By H. Kirke Swann. Part i (Vultur to Accipeter). Second edition, revised and corrected throughout. Pp. 63. (London: Wheldon and Wesley, Ltd.) 6*s*.

Fishing from the Earliest Times. By W. Radcliffe. Pp. xviii+478. (London: J. Murray.) 28*s*. net.

The Diagnosing of Troubles in Electrical Machines. By Prof. M. Walker. (Electrical Engineering Series.) Pp. xii+450. (London: Longmans, Green and Co.) 32*s*. net.

Nature Lessons with Plants. By E. Kay Robinson. (Nature Lovers' Library.) Pp. 136. (London: Holden and Hardingham, Ltd.) 1*s*. net.

Nature Lessons with Animals. By E. Kay Robinson. (Nature Lovers' Library.) Pp. 144. (London: Holden and Hardingham, Ltd.) 1*s*. net.

Grasses and Rushes. By Dr. S. C. Johnson. (Nature Lovers' Library.) Pp. 143. (London: Holden and Hardingham, Ltd.) 1*s*. net.

Everybody's Book of Astronomy. By E. G. Fenner. (Nature Lovers' Library.) Pp. 144. (London: Holden and Hardingham, Ltd.) 1*s*. net.

Handbook of Chemistry and Physics: A Ready-Reference Pocket Book of Chemical and Physical Data. By Prof. C. D. Hodgman and others. Eighth edition. Pp. 711. (London: Chapman and Hall, Ltd.) 24*s*. net.

A History of the Cambridge University Press, 1521–1921. By S. G. Roberts. Pp. xv+190. (Cambridge: At the University Press.) 17*s*. 6*d*. net.

Sur l'Origine dell'Uomo: Nuove Teorie e Documenti. By Prof. V. Giuffrida-Ruggeri. Pp. xiii+269. (Bologna: N. Zanichelli.) L. 24.

Diary of Societies.

THURSDAY, OCTOBER 6.

CERAMIC SOCIETY (Refractory Materials Section) (at Institution of Mechanical Engineers), at 10.30 a.m.—H. Dewey: Refractory Materials of the London Basin.—J. H. Marlow: The Marlow Gas-fired Tunnel Oven.—P. J. Woolf: A New Type of Tunnel Kiln, Oil-fired, with many Novel Features.—Dr. A. Granger: Aluminothermic Corundum as Refractory Materials.—Prof. J. W. Cobb and H. S. Houldsworth: The Reversible Thermal Expansion of Silica.—Discussion on Gas-firing.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Air Commodore H. R. H. Brooke-Popham: Some Notes on Aeroplanes in Tropical Countries.

CHEMICAL SOCIETY, at 8.—S. J. Lewis and F. M. Wood: A New Adjustable Thermostat for all Temperatures between 0° and 100°.—A. F. Dufton: The Separation of Miscible Liquids by Distillation. Laboratory Still-heads.—A. F. Dufton: The Separation of Miscible Liquids by Distillation. A Continuous Laboratory Still.—P. K. Dutt, H. R. Whitehead, and A. Wormall: The Action of Diazo-salts on Aromatic Sulphonamides. Part I.—A. B. Manning: Neutral Salt Action on the Hydrolysis of Ethyl Formate.—A. Shimomura and J. B. Cohen: Synthetic Optical Activity.—T. A. Henry and H. Paget: Chenopodium Oil.—C. K. Ingold and E. A. Perren: Experiments on the Synthesis of the Polyacetic Acids of Methane. An Addendum to Parts I. and III.—C. K. Ingold and W. J. Powell: Experiments on the Synthesis of the Polyacetic Acids of Methane. Part IV. The Preparation of β-Carboxymethanetriacetic Acid.—The Late H. R. Le Sueur and C. C. Wood: The Mechanism of the Action of Fused Alkalis. Part II. Action of Fused Potassium Hydroxide on Phenylglyceric Acid.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—Dr. Barris and Dr. McCurrich: Case of Hæmatoma of the Vulva following Labour.—Dr. R. A. Hendry: Case of Prolonged Gestation.—Dr. F. A. Nyulasy: Polypoid Decidual Endometritis.

FRIDAY, OCTOBER 7.

CERAMIC SOCIETY (Refractory Materials Section) (at Institution of Mechanical Engineers), at 10 a.m.—General Meeting

JUNIOR INSTITUTION OF ENGINEERS (at Caxton Hall), at 8.—Dr. F. W. Edridge-Green: Colour Vision and Colour Blindness.

WEST LONDON MEDICO-CHIRURGICAL SOCIETY (at West London Hospital), at 8.30.—Sir G. Lenthal Cheatle: A Study of Breast Cancer in Relation to the Cancer Problem (Presidential Address).

MONDAY, OCTOBER 10.

ROYAL SOCIETY OF MEDICINE (War Section), at 5.30.—Sir John Goodwin: The Aftermath of War, with Reference to the Medical Service of the Army (Presidential Address).

ARISTOTELIAN SOCIETY (at 21 Gower Street), at 8.—Dr. F. C. S. Schiller: Novelty (Presidential Address).

TUESDAY, OCTOBER 11.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—A. Earland: Deep Sea Deposits.

WEDNESDAY, OCTOBER 12.

ROYAL SANITARY INSTITUTE, at 4.—Discussion on Plumbing and Sanitation on Board Ship.

NEWCOMEN SOCIETY (at Institute of Marine Engineers, 85 Minories), at 5.—G. F. Zimmer: History of Continuous Conveying Devices.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 8.—G. Watson: Industrial Standardisation (Presidential Address).

THURSDAY, OCTOBER 13.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. C. W. Kimmins: Springs of Laughter.

SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (In Lecture Room, Hotel Cecil), at 8.—Dr. Marie Stopes: Anecdotes of the Past, Present, and Future of Birth Control (Presidential Address).

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—P. Sargent: Presidential Address.

FRIDAY, OCTOBER 14.

ASSOCIATION OF ECONOMIC BIOLOGISTS (In Botanical Lecture Theatre, Imperial College of Science), at 2.30.—Dr. W. Brown and Others: Discussion on the Physiology of the Infection Process.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—J. H. Parsons: The Fourth Cranial Nerve.—E. Clarke: Milestones in Refraction Work.

SATURDAY, OCTOBER 15.

PHYSIOLOGICAL SOCIETY (at Guy's Hospital).

CONTENTS.

	PAGE
The Prevention of Venereal Disease	169
L'Espace dans la Chimie	171
Practical Anti-tuberculosis Work	172
Physics and Chemistry of Bioluminescence. By T. S. P.	174
Our Bookshelf	174
Letters to the Editor:—	
The Resting-place of Robert Boyle.—Sir William A. Tilden, F.R.S.	176
Biological Terminology.—Sir G. Archdall Reid, K.B.E.	176
The Green Colouring of Surf on the Horizon.—Dr. S. W. Visser	178
Scientific Publication.—Cecil A. Hoare	179
Behaviour in Lizards.—E. Leonard Gill	179
Breeding Periods of Newt and Slow-worm.—Richard Elmhirst	179
The Highest Inhabited House.—W. Harcourt-Bath; The Reviewer	179
The Use of the Classics.—W. M. F. P.	180
Indian Land Mollusca.—Dr. N. Annandale	180
Auroral Display of September 28–29.—Major William J. S. Lockyer	180
The Isotopy of the Radio-elements.—Dr. M. L. Neuburger	180
Water Power Development. By Prof. A. H. Gibson, D.Sc.	181
The Danish Deep Sea Expedition. (*Illustrated*)	185
Industrial Micro-biology	187
Obituary:—	
G. W. Walker, F.R.S. By C. V. B.	188
Dr. Peter Cooper Hewitt	188
Notes	189
Our Astronomical Column:—	
Antares and its Companion	193
The Bright Object Near the Sun	193
Studies of Nebulæ and Clusters	193
International Meteorological Committee	194
The International Illumination Commission	195
University and Educational Intelligence	195
Calendar of Scientific Pioneers	197
Societies and Academies	197
Books Received	199
Diary of Societies	200

THURSDAY, OCTOBER 13, 1921.

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The Aeronautical Research Committee.

THE report of the Court of Inquiry into the loss of R38 on August 24 has been issued by the Air Ministry. Its findings are important and disquieting. Having described what actually happened when the accident took place, the Court makes comment on the initiation and development of the design. Briefly summarised, the report states that a great advance on previous British airships was made with insufficient preparation and with an unsuitable organisation. It is stated that further inquiry is being made by the Aeronautical Research Committee. It is of interest, therefore, to turn to the recently issued Report[1] of that body and to read the notes relating to experiments and research on airships. Pages 11 and 21 will be found to be connected intimately with R38 and other airships, and a relevant extract is given later in this article.

In addition to the importance given to it by the accident, the Report of the Aeronautical Research Committee for the year 1920–21 is a document of considerable general scientific interest. Not only does it give an account of work done, but it also furnishes matter for comment on the growth of a new subject, and illustrates a present-day tendency to widen the idea of research to cover anything new. It is self-evident that the pursuit of new things is not necessarily desirable, and if due economy is to be observed, either a return is required to the older usage of "research" to mean progress, or a new word is necessary to express the latter idea.

At present there is a Directorate of Research in the Air Ministry, as well as the Aeronautical Research Committee, and the Report under review indicates a confusion of functions. In many respects the older organisation was better, and consisted of a Technical Department in the Air Ministry, an advisory committee to which it could refer new problems, and research establishments at the National Physical Laboratory and the Royal Aircraft Establishment for the assistance of the Committee. When first formed in 1909 by Mr. Asquith, the Advisory Committee for Aeronautics consisted of a small number of men of science dealing with an undeveloped subject; the state of aeronautics compelled them to look for general knowledge and to leave application to the internal working of the Admiralty Air Department and the Directorate of Military Aeronautics.

During the war, as in many other branches of science, extension of the boundaries of knowledge of aeronautics almost ceased in the endeavour to apply to warfare the results of earlier research, with the consequence that the Advisory Committee became almost wholly occupied with technical matters. The references were so numerous that sub-committees were formed to deal with separate branches of the subject. An organisation essentially of war type has now become a regular part of the peace system of the country, and has been called the Aeronautical Research Committee. On pages 4, 5, and 6 of the Report appear lists of the *personnel* of the various Committees, and, in spite of the repetition of names, the lists indicate a very large body of people acting as advisers. The number appears to be out of all proportion to the staffs available for carrying on research, and can be justified only, if at all, on the ground that the members are there as technical experts, and not as supervisors of research.

The Committee has no executive powers, and work for it is carried out at the National Physical Laboratory through the Department of Scientific and Industrial Research, or at the Royal Aircraft Establishment through the Directorate of Research. In such circumstances it is clear that sympathetic administration is needed if progress is to be possible; at the present moment the con-

[1] Report of the Aeronautical Research Committee for the year 1920–21. Pp. 52. (London: H.M. Stationery Office.) Cmd. 1458. 3*d*.

ditions for success appear to be non-existent. The Report (page 11) says:—

"The Committee have learnt with great regret of the decision to stop or greatly to reduce all work connected with airships, and have addressed a letter to the Ministry pointing out the importance of full-scale research, not only for airship progress, but as an essential part of general aerodynamic theory upon which the design of all types of aircraft depends."

In spite of such letter no change of policy appears to have been considered, and the closing down of all research, laboratory as well as full-scale, would have been complete but for the deplorable accident to R38. It is more than possible that the disaster would have been avoided had the facilities for full-scale research asked for by the Aeronautical Research Committee during the last two years been granted by the Air Council.

As an isolated instance this would be important, but it appears rather as a typical example and a result of bad administrative arrangements in the Air Ministry and related bodies. A further abstract (page 52) says:—

"The evidence given by pilots in the course of this inquiry showed, however, that the handling in the air of large flying boats, particularly those of F type, had given considerable trouble, and it appeared that there was little doubt that the trouble with the F boats was mainly due to weathercock instability. Further it appeared that few data have yet been collected on the lateral stability and control of any type of aircraft. The subject is of such frequent recurrence, in relation to accidents, as to warrant an extended inquiry into the present state of knowledge regarding lateral control and stability: a recommendation to this effect has been put forward, and the matter is being prosecuted."

The reply—in effect—is that the Air Ministry cannot afford to maintain the only staffs capable of such inquiry, and that the information is not considered to be worth one-quarter per cent. of the annual expenditure on the Royal Air Force. The direct saving of the money now lost by the wreck of R38 would have maintained fundamental research in aeronautics for the greater part of a generation. Whilst such a policy is being followed by the Air Council it would be a delusion to suppose that the best of aeronautical research committees could be an effective safeguard against further disasters to military and civil aircraft.

One of the more striking pieces of work detailed in the report for the year is that of the Fire Prevention Sub-Committee. Not until the end of the war was attention adequately directed to the prevalence of fire after a bad landing, and this matter was taken up by the Committee. A glance through the items enumerated on page 40 suggests that matters normally entrusted to the designers of aircraft still require much attention. It should not be necessary at this period of time to include "development of a safe system of engine installation generally" and "the avoidance of rubber and other inflammable material under the cowl" in the programme of a *research* committee.

Of the various sectional programmes, that of the Materials and Chemistry Sub-Committee most nearly approaches scientific research. The assistance of the universities has been invoked and in due course a fruitful return may be anticipated. The Committee has there taken the line of encouraging the individual worker to give of his best. It is a possible line of development, since this branch of aeronautics comes as a natural extension of well-established sections of engineering. The aeronautical engineer is interested in all the mechanical engineering tests of materials, including those on fatigue, but to an unusual degree of refinement. The limits of weight of aircraft for successful flight leave far less room for error in estimating stresses than in application to such a subject as locomotive building for railways.

In relation to aero-engines, which are a normal development from heavier internal-combustion engines, a somewhat similar use of universities and schools of technology is possible. On the other hand, the provision of a high altitude test house is peculiar to aeronautics, and for many years to come training institutions cannot be expected to provide facilities. Both in the case of specialised engine research and aerodynamics generally it appears that facilities are effectively under the control of the Air Ministry, and for progress in the next decade a more enlightened policy appears to be a preliminary requisite.

There is much more of interest in the Report, which as a whole shows the utility of a body of men who can consider a subject in relation to first principles. For its share in such work it will probably be concluded that the Aeronautical Research Committee has justified its existence. It is possible, nevertheless, that a body limited to such functions would be far more effective.

The Science of Pharmacognosy.

Handbuch der Pharmakognosie. By A. Tschirch. Band III. Lieferung 1, 1921. 10 marks. Lieferung 1–4 and Lieferung 9–37. (1908–14.) 2 marks each. (Leipzig: Chr. Herm. Tauchnitz.)

AFTER an interval of four years Prof. Tschirch has continued the publication of his compendious "Handbook of Pharmacognosy" and issued the first part of the last volume. About twenty parts will constitute this section, which will deal with the drugs containing phloroglucin derivatives, tannins, alkaloids, antigens (toxalbumins), bitter principles, vesicants, colouring principles, resins, and a few other groups. Part i. deals with such drugs as male fern, cusso, kamala, cutch, gambier, and kino.

Pharmacists and all who are interested in drugs may look forward to the approaching completion of what is undoubtedly the most ambitious literary attempt that has ever been made in the field of pharmacognosy. By pharmacognosy the author means the science which has for its object the acquirement of a complete knowledge of animal and vegetable drugs, their correct description, and their rational grouping under general headings. Pharmacognosy, according to Prof. Tschirch, should no longer remain a collection of individual drug descriptions, however perfect they may be; these must be welded together into an independent science many of the problems of which are capable of experimental solution. To attain this object, chemistry, botany, zoology, physics, and every science that can give assistance must be laid under contribution. With this end in view the author, as is well known, has laboured with his pupils in the University of Berne for the last twenty-five years, directing during that time innumerable researches chiefly in the fields of the botany and chemistry of drugs.

The work is divided into general and applied pharmacognosy. Under the first heading the author deals with the cultivation of medicinal plants, the collection and preparation of the parts used as drugs, the commerce, sorting, packing, etc., and with the subsidiary sciences of botany, zoology, chemistry, physics, geography, history, ethnology, etymology, etc. Most of these subdivisions have had special terms coined for them; thus cultivation is designated "pharmacoergasia," commerce "pharmacoemporia," chemistry "pharmacochemistry," and so on. Pharmacoergasia (117 pages) consists of a compilation of facts concerning the cultivation of various drugs, and is a somewhat heterogeneous collection the systematic arrangement of which would be attended with considerable difficulty. Commerce (42 pages) lends itself better to separate treatment, and the section is exceedingly interesting. The subject of the history of drugs, to which no fewer than 558 pages are devoted, also makes excellent reading; under this heading the history of drugs from the earliest records to modern times is fully discussed.

Among the subsidiary sciences, Prof. Tschirch regards pharmacochemistry as the most important, since the value of a drug depends, in the majority of cases, on the constituents contained in it. For this reason the classification of drugs should be based on the relationships of the chief constituents. Such a classification has been adopted by the author in the second part of his work (applied pharmacognosy), although he admits that in his opinion only 1 per cent. of the drugs known have been sufficiently investigated. Under this system the larger groups, such as the sugars, starches, celluloses, aliphatic acids, fats, volatile oils, resins, aromatic phenols, tannins, glucosides, and alkaloids, are subdivided into smaller ones; thus the group of alkaloidal drugs is subdivided according to the constitution of the principal alkaloid. It would therefore be impossible to classify correctly any alkaloidal drug until the constitution of its principal alkaloid was known. The rapid strides that are now being made in our knowledge of the chemistry of drugs are reducing this objection to a chemical classification, but a very long time must elapse before a satisfactory position can be attained.

The treatment of each individual drug in the second part is very complete. First the synonyms are given; then the etymology, the botanical source, the pests to which the plant is subject, its cultivation, harvesting, commerce, morphology, anatomy, characters of the powder, chemistry, adulterations, uses, and so on, are discussed in the fullest detail, the bibliography being particularly complete. In the case of rhubarb the space devoted to the description is thirty pages, including numerous illustrations. The weakest point is certainly the microscopical characters of the powdered drugs; these are usually dismissed in a few lines, the author relying almost entirely on his description of the anatomy.

Even with the assistance afforded by his colleagues and pupils, Prof. Tschirch's task has been a stupendous one; he has accomplished it with conspicuous success, and the handbook will doubtless be for many years a mine of information for pharmacognosists. Nevertheless, the advisability of publishing so large a work in a succession of parts appearing at somewhat distant intervals may

well be doubted. By the time the last appears the first will be at least fifteen years old, and scientific works age very rapidly. The division of the handbook into several volumes for each of which one or more experts should be responsible would appear to be a better plan.

Human Physiology.

Human Physiology. By Prof. Luigi Luciani. With a preface by Prof. J. N. Langley. (In five volumes.) Vol. 5. *Metabolism—Temperature—Reproduction, etc.* Edited by Prof. M. S. Pembrey. Pp. viii+422. (London: Macmillan and Co., Ltd., 1921.) 30*s.* net.

THIS, the fifth and final volume of Luciani's notable "Human Physiology," is as full of interest and originality of treatment as any of the previous volumes. Messrs. Macmillan deserve every credit for having borne the cost of translation and production of probably the last great attempt by a single individual to deal with physiology in full detail. It is true that for exhaustiveness of treatment we must resort to works prepared by several authors, or to the still fuller monographs. Undoubtedly we get a more complete account written by a specialist in the particular section, but it is questionable if the light and shade are so good as in the old-fashioned single-author type of book. Too often the little section, no doubt an important part of the whole, is almost dragged from its context and set in the full glare of the limelight. For specialists in the subject this is perhaps of no great moment, as they can perform the necessary correction, but for the average intelligent worker who desires information in a subject perhaps cognate to his own this triumph of specialism may be neither suitable nor very enlightening. Granted that the great chance of failure in the one-man book lies in the fact that the author has a bias, nevertheless this very deficiency lends a colour and virility which are frequently absent from the more scientific and coldly critical monograph—indeed, provided the author is broad enough in his views, this bias may be regarded as a definite asset.

Luciani's work, despite its defects, is a living, stimulating book written by a physiologist with a broad and sane outlook. It is a work which the professional physiologist, the ordinary medical practitioner, and the medical student can read with pleasure and profit. Its great value—and the present volume is no exception—is the amount of space which is devoted to sections of physiology which are, as a rule, but shabbily treated in other text-books. On the other hand, sections which might merit more complete treatment in the light of modern interest and research are, on the whole, less thoroughly done than in many smaller books. Thus, in the volume under review the question of the accessory food factors is confined to a brief note by the editor.

As regards the present volume, the first three chapters deal with different phases of metabolism. These chapters give a most excellent historical survey of the development of the subject. The account of the gradual appreciation of the fact that all proteins are not of equal value, gelatine being taken as the example, is particularly interesting and valuable, and, in view of the modern trend of ideas, very suggestive. A good deal of space is also devoted, with propriety, to the much-neglected subject of mineral metabolism. Luciani's final conclusion as regards metabolism in the exchange both of matter and of energy, whether of each tissue or of the organism as a whole, is of interest, as he believes that the regulation is "the fundamental function of the nervous system considered as a whole and a unit, and not of one or other part or segment."

The next three chapters are devoted to a full discussion of reproduction. These chapters are full of valuable information—perhaps not quite so detailed as in the original—much of which is very difficult to find elsewhere. The fact, too, that parturition is dealt with in considerable detail as a purely physiological phenomenon is excellent. These chapters are followed by a suggestive and stimulating chapter on the stages of life and death. Apart from Dastre's book—and in some respects this single chapter even excels that striking work—it would be impossible to refer to a more complete source for out-of-the-way details in many varied aspects of physiology. It has also the merit of being eminently readable philosophy. Like Luciani's sane pronouncement on the rival claims of vitalism and materialism in an earlier volume, his closing sentence to this chapter, and incidentally to his own part of the work, is personally illuminating:—

"In order to ensure ourselves this ideal *euthanasia*, we have but to convince ourselves that *materialism* is utterly unable to afford any explanation of the most ancient problems of man and the universe; belief in *philosophy*, in the spiritualistic or even the idealistic hypothesis, is all that is needed to enable us to estimate life aright and to look death in the face, if not with a smile on our lips, at all events with calm resignation and confidence based upon hope."

The final chapter, as Luciani states in a footnote, was prepared by his assistant, Prof.

Baglioni. It gives a rapid summary of ethnology and anthropology—good in its way, but, owing to shortage of space, too compressed to be of real value. The point is emphasised that modern sociology shows a marked tendency to state and solve its various problems in terms of physiology.

To Prof. Pembrey is due hearty congratulations for the judicious and careful way in which he has edited the volume. It must have required endless patience and time. The translation is good, and the number of actual errors detected but few. The publishers have produced a book of pre-war standard in paper, printing, illustrations, and binding. It is a pity, however, that a complete index for the five volumes was not incorporated in this concluding volume.

E. P. C.

Principles of Electrical Engineering.

Electrical Engineering. By Dr. T. F. Wall. Pp. xi+491. (London: Methuen and Co., Ltd., 1921.) 21*s.*

A SURVEY of the principles of electrical engineering intended for students in universities and the advanced classes in technical schools is given in this book. The author's treatment of the subject can be commended, although in places the condensation will make it difficult for the uninitiated to follow his reasoning. He begins by a careful discussion of electrostatic theory, proving, in some cases by novel methods, the capacity formulæ which are used by engineers. He describes how the dielectric is sometimes graded in high-tension cables, and shows how the requisite calculations to find the electric force in the dielectric can be made. No mention is made, however, of the severe limitations imposed on the use of intersheath methods of grading by the large capacity current which flows in the sheath. The corona effect is mentioned, but the formula given is not so accurate as that due to F. W. Peek. The formulæ for the sparking voltages between spheres are not given.

On p. 194 it is stated that the standard values for the resistance of copper at present in use are those found by Matthiessen. This is not the case. Electricians use the international standard of resistance for copper given in Publication No. 28 of the International Electrotechnical Commission. They also find it advisable to use three temperature coefficients: the "constant-mass" temperature coefficient, the volume resistivity and the mass resistivity temperature coefficients.

On p. 202 Newton's law of cooling is given as if it applied to radiation instead of to convection. It is deduced that the melting current of a fuse wire varies as the 1·5th power of the diameter instead of the 1·25th power, which follows from more accurate theory. On p. 381, l. 11, we take it that "two-thirds" is a misprint for "three-halves," as the capacity between two wires is obviously increased by bringing a third wire into the neighbourhood.

The author attacks the problem of practical harmonic analysis in the proper way. He takes the Fourier solutions for a_n and b_n, the coefficients of the cosine and sine components of the Fourier series, and computes their values by mathematical quadrature. Taking m ordinates for the half-wave, he writes:—

$$a_n=\frac{2}{m}\left[y_1\cos n\frac{\pi}{m}+y_2\cos n\frac{2\pi}{m}+\ \ldots\ +y_m\cos n\frac{m\pi}{m}\right],$$

and a similar formula for b_n. Taking $m=10$, he finds the first, third, and fifth harmonics for a given curve, and suggests that a similar analysis will give the higher harmonics. It should have been stated that more ordinates would have to be measured if the higher harmonics are to be determined accurately.

In our opinion the first and third harmonics are best determined by dividing the base of the positive half of the wave into twelve equal parts and then applying Weddle's rule. To make reasonably certain of finding the fifth harmonic accurately it would be necessary to divide the base into eighteen, or better twenty-four, equal parts, and draw the ordinates at the points of division. If we apply the author's method to a rectangular wave of height unity, we get $b_1=1{\cdot}263$ and $b_3=0{\cdot}393$. The true values, 1·273 and 0·424, are given by Weddle's rule.

A. R.

Semi-popular British Botany.

A New British Flora: British Wild Flowers in their Natural Haunts. Described by A. R. Horwood. Vol. 3, pp. xi+251+plates 18–31; Vol. 4, pp. xi+257+plates 32–49; Vol. 5, pp. xi+234+plates 50–64; Vol. 6, pp. xix+232. (London: The Gresham Publishing Co., Ltd., 1919.) 12*s.* 6*d.* net each vol.

THE first two volumes of this work were reviewed in NATURE of April 21 last, p. 232. Vol. 3 deals with flowers of the woods and copses, roadsides and hedges, while the fourth volume presents the flowers of "mountains, hills, and dry places," "lakes, rivers, ditches, and wet places," "waste places, gardens, refuse-heaps, village greens, farmyards, etc." While thoroughly unbotanical in that it scatters

the various species of the same genus, yet in a semi-popular work of this kind the method has much to be said for it. The coloured plates are beautifully done, and the photographs, of which there is at least one for nearly every species, are almost uniformly excellent, and many of them are triumphs of art. Perhaps the best feature of the work is that the photographs in almost every case show the habit of the plant in its native haunts. Where the plant is shown as part of a landscape the effect is often beautiful, as in the photographs of a reed swamp on a Norfolk broad and of the great yellow watercress. In a photograph such as that which is meant to illustrate the duckweed, the latter occupying only a small patch on the water surface, the conspicuous elements of the vegetation which fill the rest of the figure might have been indicated by marginal names. The "close-up" photographs are almost uniformly successful, and we know of no other series to equal them. Occasionally, however, as in the photograph of the bugle (*Ajuga reptans*), the plants are too closely surrounded by other vegetation to show their distinctive features. The figure of the lily-of-the-valley is evidently taken from a garden. Anyone who has seen it flowering wild in an English copse would wish that the more dainty wild plant might have been captured by the camera in its natural surroundings. The distribution of each species in Britain is given in considerable detail, together with the various local names and a mass of folk-lore the utility of which is somewhat doubtful.

Vol. 5 deals with the flowers of bogs and marshes, heaths and moors, rocks and gravelly places. The same high quality of the illustrations is maintained, and many of the photographs show not only the plant concerned, but also the ecological association in which it flourishes. The last part of this volume includes "Hints and Notes," chiefly on matters ecological, with reference to the plants described. An appendix contains a summary of the natural orders, and short diagnoses of the genera (520) of British flowering plants. This is followed by a bibliography of general works on such matters as the origin and distribution of the British flora, the ecology, pollination, soil, fungal and insect pests, and folk-lore of British plants. A glossary completes the volume.

The sixth and final volume gives unillustrated descriptions of species not included in the earlier volumes. The London Catalogue of British Plants (1908) enumerated nearly 2000 species, and Mr. Druce's British Plant List includes some 3000, of which more than 1000, however, are aliens. About 147 species are considered endemic, consisting mainly of Rubi and Hieracia.

Differing somewhat in character from any previous treatment of the British flora, this work is particularly to be commended as a semi-popular account emphasising the ecological and natural history aspects, embellished with numerous photographs which for the most part are very carefully selected. It must be said, however, that the ecology is not of a very serious kind.

R. R. G.

Our Bookshelf.

Gynecology. By Dr. Brooke M. Anspach. Pp. xxvi+752. (London: J. B. Lippincott Co., 1921.) 42*s.* net.

We have here an excellent treatise—exhaustive, clear, well illustrated. The like may be said of many medical books, but the present work is especially good in that it links up, better than most of its predecessors, the student's early scientific work with his later practical instruction. An unavoidable fault of medical training is that it is conducted by relays of specialists, each of whom concentrates on a single subject and trenches as little as possible on the work of his colleagues. First one group of subjects is laid aside, then another, and so on. Theoretically the endeavour is to base practical efficiency on antecedent scientific knowledge; but the human mind forgets as well as learns, and the curriculum is long. Commonly at the end of it something of anatomy, physiology, and biology has faded from the mind of the budding surgeon, physician, and student of man. However well equipped to deal with cut-and-dried matters in established ways, he may fail, through lack of understanding, to meet strange emergencies with new expedients. Becoming a practitioner, he may not remain a thoughtful man of science. In the present work all that is necessary to a full understanding is dealt with lucidly, if briefly. The immediate subject-matter is handled as clearly, but in greater detail. The book may be cordially recommended, for it is very good.

New Alt-Azimuth Tables, 65° N. to 65° S. Pp. xvii+154. (Tokyo: Hydrographic Department, 1920.)

Since the very general adoption of the method of navigation known as the Marcq system of position lines, in which, whatever the azimuth, the position line is determined by one and the same problem, the calculation of altitude, many attempts have been made so to simplify the working that the results can to a great extent be effected through the medium of suitably arranged tables by simple inspection. A fresh attempt of this nature forms a leading feature of the excellent little work recently issued by the Hydrographic Department at Tokyo. Like other tables of the kind, such as

those of the Rev. F. Ball, R.N., and of Capt. Aquino, of the Brazilian Navy, Mr. S. Ogura, the inventor of the method, commences by assuming such a point upon the chart that latitude and hour-angle are each represented by an exact number of degrees. In the subsequent procedure, however, he differs wholly from the methods of his predecessors, and by means of but one special table, occupying only eighteen pages, carries out his purpose in a manner which, in point of simplicity, is certainly not inferior to anything that has gone before. A second table of about nine pages is added, but this is nothing more than a specially arranged table of logarithmic secants, convenient, but not in any way indispensable to the principle upon which the method is based.

Other new and original tables given in the volume are those for finding azimuth, identifying an unknown star, and so forth, and the contents afford a fresh proof that no effort is spared by the Japanese naval authorities to keep in close touch with the many developments in the science of navigation that have taken place in recent years.

Le Destin des Etoiles: Etudes d'Astronomie Physique. By Svante Arrhenius. Traduction française par T. Seyrig. (Nouvelle Collection scientifique.) Pp. v+224. (Paris: Félix Alcan, 1921.) 8 francs net.

THE course of development of suns and planets from the primitive nebula to planetary death is discussed in this book. It deals first with the Galaxy, describing the conclusions of Wolf, Easton, Seeliger, Charlier, and Shapley on its extent and structure. The author ascribes the two great star streams to the interpenetration of two cosmic clouds, the rapid rotational motion of certain nebulæ that is revealed by the spectroscope being supposed to arise from the collision of nebulous masses in the course of this interpenetration. He holds that the dark regions in the Galaxy have been swept clear by the passage of cosmic clouds.

Several chapters are occupied with planetary atmospheres and with the changes that they probably undergo in the course of the planet's development. It is suggested that free oxygen is not present until the surface is sufficiently cool to be fit for the support of life. The habitability of the planets is also discussed, the moon and Mercury being classed as dead worlds, Mars as possibly supporting low forms of vegetation, while Venus is supposed to be in the carboniferous stage.

The book can be recommended for its bold speculations, which include in their scope much recent observational work.

A. C. D. CROMMELIN.

Kentucky Superstitions. By Dr. D. L. Thomas and Lucy B. Thomas. Pp. viii+334. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1920.) 12*s.* 6*d.* net.

UNTIL recently Kentucky was the most remote and primitive of the States of America. Among the Mountain whites, as is well known to students of American social conditions, the law did not run; they lived in conditions which were practically tribal, and the most prominent features in their social habits were the blood-feud and the illicit still. The Lowland whites and negroes, the remaining elements in the population, were also very little touched by outside influence. It is therefore not surprising to find that the compilers of this collection have been able to get together more than four thousand instances of superstitions, among which a firm belief in witchcraft and in the efficacy of charms and magical cures in illness figures prominently. A large proportion of these beliefs will be familiar to students of British folklore. As the Kentucky population was derived mainly from the Carolinas, Maryland, and Virginia, these superstitions have a pedigree going directly back to England in the seventeenth century. The authors consider that the negro has assimilated white folklore, his only contribution being the Voodoo or Hoodoo beliefs. Certain elements, however, suggest that a closer examination might modify this view.

Notes on Dynamics, with Examples and Experimental Work. By Terry Thomas. Pp. 123. (London: Crosby Lockwood and Son, 1920.) 6*s.* net.

THE "notes" issued by Mr. Thomas deal with a fairly wide range of dynamical problems, and there are hundreds of excellent exercises, but this is all one can say in their favour. The diagrams are very roughly drawn, and the whole style of the book is reminiscent of the student's lecture notes. Thus one must object to a statement like "The engineer unit of mass is M/g, where M is the mass in pounds, and $g=32{\cdot}2$"; or "The various forms of energy are: potential, kinetic, heat, electrical, and chemical"; or "Neglecting the effect of the axle, the moment of inertia of a flywheel is $MR^2/2$," without saying anything about the construction of the flywheel; or "$I_z=I_x+I_y$" in dealing with moments of inertia, without mentioning that this refers to a plane lamina.

The author is of the opinion that it is much safer for beginners to reduce all forces to poundals and dynes, and carries this doctrine so far as to introduce the term "tondal." This is an interesting opinion, but it is very doubtful whether many teachers will agree with it.

S. BRODETSKY.

Countryside Rambles. By W. S. Furneaux. (New Era Library.) Pp. lvi+186. (London: George Philip and Son, Ltd., n.d.) 3*s.* 6*d.* net.

As a populariser of natural history Mr. Furneaux is already well known. In the present volume the contents of which are arranged in accordance with the four seasons, attention is directed to many of the more striking objects and phenomena, chiefly botanical and zoological, that are likely to come within notice during walks in the country. It is lightly and pleasantly written, and the forty-six plates of photographic illustrations are very successful.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Occurrence of the Aurora Line in the Spectrum of the Night Sky.

I HAVE pursued the line of work outlined in my letter to NATURE of March 31, 1921 (vol. 107, p. 137). The result has been to show that at Terling, Essex, the aurora line can be photographed on two nights out of three. Exposures were made on 150 nights, irrespective of weather.

The intensity on ordinary occasions appears to have little or no connection with magnetic disturbance or the distribution of spots on the sun. The most interesting point that has come out, however, is that the aurora line is much stronger at Terling than at Beaufront Castle, near Hexham, Northumberland. I have made exposures on twenty-six different single nights at the latter place, and have never found a trace of the aurora line on any of them, though the same instrument and the same kind of plates were used as at Terling.

Positive results at Terling were sandwiched in between the negative results at Beaufront; thus the latter cannot be attributed to seasonal variation.

Five nights' cumulative exposure have been tried on two occasions at Beaufront, and on each plate the aurora line was obtained.

I have been very much astonished at this diminished intensity of the aurora line as one goes north. The difference of latitude is about 3°. It would seem that the aurora line as photographed in the south of England will not fit into the scheme of distribution of the polar aurora. I hope to pursue this line of work to the north and to the south as opportunity may offer. RAYLEIGH.

October 9.

Atomic Structure.

IN connection with the problem of the constitution of the atom discussed in my letter to NATURE of March 24 last (vol. 107, p. 104), I should like to add a few complementary remarks about the manner in which the orbits of the electrons in the atom are characterised.

According to this view of atomic constitution, the electrons in the atom are arranged in groups in such a way that the orbit of every electron within one and the same group is characterised by the same total number of quanta. Since, however, for orbits characterised by more than one quantum there exist several types of orbits possessing the same total number of quanta, the electrons within each group do not in general play equivalent parts, but are divided into a number of sub-groups corresponding to different types of possible orbits. Now it is a salient feature of this picture that the atom cannot be said to be composed of a number of well-defined spherical shells of electrons moving in sharply separated regions of the atom. In fact, although the electrons of a given group mainly move within one and the same shell-shaped region of the atom, the electrons, at any rate of certain sub-groups, will in their revolution penetrate into the region of the orbits of the electrons of inner groups. This gives rise to a coupling between the various groups, which is an essential feature of the interpretation of the stability of the atom. As a consequence of this, the orbit of an electron may be considered from different points of view, according as attention is mainly paid (1) to the larger part of the orbit which lies outside the region of inner groups, and which nearly coincides with an almost closed Keplerian ellipse, or (2) to the mechanical properties of the whole orbit, regarded as a type of central orbit composed of loops which only in their outer part possess an approximately Keplerian character.

Now in the classification described in my former letter the orbits were regarded from the first, and more superficial, point of view. The numbers of quanta characterising the orbits of the electrons in the different groups correspond to Keplerian ellipses, which coincide approximately with the outer parts of the orbits of the electrons in question. It has since been possible, by a detailed examination of the parts of the orbital loops situated within the region of inner groups, to classify the orbits from the second, and more fundamental, point of view, leading to a simple and unambiguous result. In fact, we are led to a classification in which, when we proceed outwards from the nucleus, the number of quanta characterising a certain group of orbits is always larger by one unit than that of the preceding group. For the groups in the inner region of the atom, where the attraction of the nucleus preponderates, this new rigorous classification coincides with the old one of my former letter. But it departs from the old for groups in which the orbits of the electrons mainly fall in the outer region of the atom, where the attraction of the nucleus is largely compensated for by the repulsion of the electrons in the inner groups. For these groups the quantum numbers of the orbits given in my former letter were equal to, or even smaller than, those of inner groups.

Notwithstanding the essential progress made by this modification in the classification of the orbits, the main features of this model of the atom remain the same. For instance, my former statements of the numbers of electrons in the various groups and sub-groups in the atom hold unaltered for all groups. In fact, in fixing these numbers by the correspondence principle we find them to depend on the harmony of the motion of the electrons within each single group. They depend, therefore, primarily on the relative dimensions of the approximately Keplerian loops, and only secondarily on the way in which these loops are joined together to form complete central orbits. Thus the previous model of the atoms of the inert gases holds unaltered also as regards the outer groups, provided that the numbers stated as defining the number of quanta of the orbits in the various groups are considered instead as defining the number of sub-groups within the corresponding groups. Moreover, the numbers in question offer an approximate estimate of the spatial extension of the regions of the orbits of the electrons in the different groups in the atom. For instance, the orbits in the outermost "shell" in the Niton atom must be characterised as six-quanta orbits instead of as two-quanta orbits; but the dimensions of the orbital loops will by no means be of the same order of magnitude as those of the orbit of an electron revolving in a Keplerian orbit characterised by six quanta in the region outside that of the orbits of the electrons in the five inner groups; they will rather be of the same order as those of a similar Keplerian orbit characterised by only two quanta.

From these remarks it will be seen that my former applications of the theory to the interpretation of the physical and chemical properties of the elements

remain in substance unaltered. At the same time the elaboration of the theoretical considerations sketched in this letter throws a good deal more light on the interpretation of many details. For instance, it is possible to account for the appearance in the atom, with increasing atomic number, of groups of new constitution in such a way that we obtain a natural interpretation not only, as before, of the existence of such families of elements in the periodic table as those of the iron metals and the rare earths, but also of the almost complete absence of any effect on the Röntgen-ray spectra of the appearance of such groups. This absence is explained by the fact that in these families we do not witness any sudden change with increasing atomic number in the total number of quanta of the orbits of the electrons of certain groups. On the contrary, we may be assumed to witness in the appearance of each of these families the completion of a group by the inclusion of further electrons moving in orbits characterised by the same number of quanta. This addition to the group is brought about by a change in the interaction between the various possible types of orbits with this number of quanta caused by the alteration in the dimensions of the orbital loops and in the "apparent" number of quanta which may be said to characterise these loops.

I have confined myself here to these points of general character. For details of the theory and its applications I must refer the reader to a paper in preparation for publication by the Royal Danish Academy of Science. N. BOHR.

Copenhagen, September 16.

The Separation of Chlorine into Isotopes.

IN NATURE of April 22, 1920 (vol. 105, p. 230) Harkins and Broeker reported that they had obtained a partial separation of the element chlorine into isotopes. Five determinations made early in February of that year showed atomic weight increases of 0·052, 0·059, 0·057, 0·055, and 0·053 unit of atomic weight. Assuming that ordinary chlorine has an atomic weight equal to 35·460, the new chlorine as separated had an atomic weight equal to 35·515.

Shortly after the publication of this report in NATURE the progress of the separation was stopped by the death of Mr. Broeker. Soon after this an entirely independent diffusion was begun by Dr. Anson Hayes and the present writer, using new apparatus and a different source for the hydrogen chloride. In this way about twenty grams of chlorine which has an atomic weight higher by 0·0375 unit than that of ordinary chlorine, and eighty grams with an atomic weight higher by 0·034 unit, have been obtained, together with several kilograms the atomic weight of which has not been determined, but must be more than 0·2 unit high in order to give the results cited above. Thus far the effort has been to collect considerable material for future work rather than to get the maximum increase of atomic weight. The details of this work were reported to one of the American chemical journals in April of this year, but publication may be delayed many months by a strike of the printers.

The atomic-weight method used gave results accurate to 0·003 unit of atomic weight, and consisted in determining the amounts of acid in samples of ordinary and isotopic hydrochloric acid of the same density. The pyknometer was made in such a way as to give high precision, and the thermostat was regulated to 0·001°. Eighteen atomic-weight determinations were made.

Absence of impurities, and especially of bromine and iodine, was ensured by using only the purest materials in the diffusion in an apparatus consisting of glass and porous porcelain only, and by recrystallising the chlorine from water in the form of sodium chloride three times and by precipitating it once in the same form by passing in isotopic hydrogen chloride gas. In addition to this, two fractional distillations with potassium permanganate and one fractional distillation without this substance were used.

Mr. T. H. Liggett, who worked with the present writer on this problem in the year 1917–18, has reported that he also has secured an increase of 0·05 in the atomic weight of chlorine by using the same method—the diffusion of hydrogen chloride gas.

Thus we have definitely confirmed the separation reported by Harkins and Broeker.

WILLIAM D. HARKINS.

University of Chicago, August 28.

The Pickering Series in O Type Stars.

IF the Pickering series, consisting of the lines 5411, 4542, 4200, etc., in stellar spectra, is due to ionised helium, it is known from the investigations of Fowler and from Bohr's theory that there must be additional lines which appear as violet components of the Balmer series of hydrogen. As these components have an average separation of 2 Å. they should be readily seen in the spectra of O type stars. Unfortunately, there are two unfavourable circumstances: first, the O type stars are all faint, and, secondly, the lines of both the Balmer and the Pickering series are in general so diffuse as to be hopelessly blended.

A preliminary survey was made here last year of O type stars for the purpose of selecting one or more stars of reasonable brightness and with fairly sharp lines. As a result 10 Lacertæ, type Oe 5, magnitude 4·9 was selected as the most suitable star for tests with higher dispersion. On resuming work this year the director, Dr. J. S. Plaskett, directed attention to 9 Sagittæ, type Oc, magnitude 6·2, as also a very suitable star. After some preliminary experiments, two plates of 9 Sagittæ and 10 Lacertæ with three-prism dispersion (10 Å. to 1 mm. at Hγ) were secured on August 12 which showed components at Hβ and Hγ at the theoretical separation. With this as a start, check plates were secured, and in addition high dispersion plates, requiring 9–10 hours' exposure were secured of the region around Hα in 10 Lacertæ. The preliminary wave-lengths on the international scale of the complete Pickering series, and also of the Balmer series, are summarised in the following table:—

Pickering series.		Balmer series.	
Star.	Computed.	Star.	"Star – Lab."
6559·71 [1]	6560·15	6562·79 [1]	± ·00
5411·54	5411·53		
4859·07 [2]	4859·35	4861·34	+ ·01
4541·65	4541·62		
4338·77	4338·70	4340·45	− ·02
4200·00 [3]	4199·86		
4099·96	4100·00	4101·70	− ·04

[1] The wave-length of Hα was assumed in order to determine the position of the other component. Measures of the Hα component were difficult to make, partly on account of the small linear dispersion and partly because of the existence of a line 6558·6, origin unknown.

[2] Blend with Fowler's enhanced nitrogen line 4858·82 in 10 Lacertæ. In 9 Sagittæ there is no component, as it is probably obliterated by the enhanced nitrogen line appearing as emission.

[3] Blend with Fowler's enhanced nitrogen line 4200·06.

The first column contains measured wave-lengths of the Pickering series in the star, the second the computed values, the third contains the measured wave-lengths of the Balmer series in the star, and the fourth the residuals, star–laboratory, using Curtis's wave-lengths. In view of the closeness of the agreement between the observed and computed values, there can be no doubt as to the existence of the helium components of the Balmer series, and hence no doubt that the Pickering series is due to enhanced helium.

Using these preliminary wave-lengths, corrected to vacuum, the value of the constant N_{He} in Bohr's formula, $n = N_{He}\left(\frac{1}{4^2} - \frac{1}{m^2}\right)$, for the Pickering series has been computed for all lines except those with footnotes. The weighted mean, using in addition the measured wave-length 4685·76, comes out N_{He}=438 890·3, with a total range of 16·8. From the well-known formula:

$$\frac{m_0}{M} = \frac{N_{He} - N_H}{N_H - \frac{1}{4}N_{He}},$$

arising from the correction to Böhr's simple theory on account of the motion of the nucleus, the mass of the electron m_0 in terms of the mass M of the hydrogen atom comes out $\frac{1}{1851{\cdot}6}$. The revised values of the wave-lengths which will result from additional plates and re-measures should give a value of the electron mass of a high degree of accuracy.

In a recent paper (Proc. Roy. Soc., A, vol. 99, p. 135, 1921) Saha has predicted that at about the stage Ob in stellar spectra the Balmer series disappears and is replaced by the Pickering lines 6560, 4859, 4339, 4100. Reference to his tables shows that the enhanced Mg line 4481 should disappear at a still higher temperature than the Balmer series. In the star 9 Sagittæ the line 4481 has almost disappeared. In fact it has only been glimpsed on one of several plates. However, at Hγ there are lines at 4340·4 (Hγ) and 4338·8. Further, Hγ is about six times as intense as the Pickering component. This non-verification of Saha's prediction is scarcely surprising when it is recalled that the nebulæ, which are probably more advanced than O type stars, show the Balmer series (Lick Observatory Publications, vol. 13).

H. H. PLASKETT.

Dominion Astrophysical Observatory,
Victoria, B.C., September 17.

Radiation and Chemical Action.

IN the *Philosophical Magazine* for November, 1920, Prof. Lindemann has shown that if Prof. W. C. McC. Lewis's hypothesis is true, *i.e.* that the velocity of a chemical reaction is proportional to the intensity in the system of the radiation of a wave-length which is characteristic of the reaction, then in the case of the inversion of cane-sugar by dilute acid, exposure to the radiation of the sun should increase the reaction velocity 5×10^{13} times.

Recently Prof. Lewis has suggested that any such effect would not be true for the conditions under which such a reaction is usually carried out, because the activating rays lie in the region of 1μ, and at this wave-length water, the solvent, would absorb the radiation almost totally in the first thin layer, so that the bulk of the liquid would remain unaffected.

In order to test the radiation hypothesis, paying heed to Prof. Lewis's suggestion, the following simple experiment has been carried out. A solution containing 100 gr. of cane-sugar and 3·65 gr. of hydrogen chloride per litre was made up and divided into two portions. One was left to stand indoors at room-temperature (14·7° C.), while the other was forced upwards through four fine jets made from 3 mm. diameter glass tubing drawn out to the narrowest of capillaries; this treatment took place on the roof in full sunshine. The liquid from the jets formed fine columns about 8 cm. high, which then broke up into clouds of small drops, the drops rising a further 40 cm. They were allowed to fall, and collected in a large dish; the temperature of the resulting liquid had risen to 19·1° C.

Now for the cane-sugar at the concentrations used the period required for half to be inverted is at 20° C. from Lewis's measurement of the velocity constant, $1{\cdot}6 \times 10^5$ seconds, or approximately 47 hours. On Lewis's hypothesis, illumination by the sun should reduce this to 3×10^{-9} seconds; hence it was reasonable to expect some indication of a more rapid change in the exposed portion if the hypothesis were true. Two polarimeter tubes were filled, one with the exposed portion, the other with the unexposed. The rotations measured were:—Unexposed solution, 13·06°; exposed solution (measured 2 min. later), 12·82°. In other words, illumination by the sun had had no appreciable effect on the reaction velocity.

The size of the drops in which the one portion had been exposed was measured later by catching drops of the same solution formed under the same conditions on black velvet and measuring them under a microscope. They were of pretty constant size, the average diameter being 0·015 cm. It is thus difficult to imagine that the absence of any effect was due to absorption by the solvent. Further, from Stokes's formula the size gives an average time of fall 0·68 second, so that the time of exposure is ridiculously ample. For even if the radiation density at 1μ had been reduced inside each drop, by absorption, to 10^{-8} of its value, which is unlikely, then a rough calculation, assuming the truth of the hypothesis, shows, that an exposure for this time should result in a difference in polarimeter reading for the two solutions of about 13°, instead of the observed 0·24°.

It is, of course, realised that this simple experiment has no bearing upon M. Perrin's version of the radiation hypothesis, in which the reactants are supposed to absorb several quanta of considerably longer wave-length than 1–2μ. But this also can be tested directly by experiments, which it is proposed to carry out here as soon as possible.

T. W. J. TAYLOR.

Brasenose College, Oxford, October 2.

Qualities of Valency.

IN his article in *Science* of July 22 (see NATURE, September 15, p. 101), and in his address to Sections A and B of the British Association at Edinburgh, Dr. Irving Langmuir asks us to believe that the sodium and chlorine atoms in sodium chloride are never united by a chemical *bond, i.e.* that the salt is ionised in its synthesis and remains ionised under all conditions. This appears to be a denial of the existence of NaCl molecules, yet such molecules exist in the state of vapour at *cir.* 2000° C. Are we, then, to suppose that sodium and chlorine ions are held together at this temperature by electrostatic attraction only? Difficult to reconcile with this idea, if it is applied to salts in general, are the phenomena of aqueous solutions of some salts—mercuric salts, for example—which are attributed to imperfect ionisation and the increase of specific conductivity of imperfect

electrolytes on dilution. These difficulties, if they are real, might be removed by reverting to the idea of electrons acting as binding material in compounds capable of ionisation instead of supposing that they have passed completely and irreversibly over from the positive to the negative atom and have been incorporated into the sheath of the latter. This is not to confuse electrovalency with covalency, for the essential difference between the two kinds of valency is still that electrons are transferable in the one case and not in the other.

It is apparent, however, that Dr. Langmuir regards ionisation in a wider sense than is usual from his statement that "compounds without covalency must consist of positively and negatively charged ions"; and that among such compounds he places SF_6, because the sulphur atom is sufficiently positive to yield to the powerful attraction of the fluorine atoms for electrons.

In this connection I would like to direct attention to the unique characteristics of the elements of the first short period as compared with those of the second short period and following periods, and to inquire whether Dr. Langmuir's theory can afford an explanation of them.

The hydrides of the first short period are inert compared with corresponding hydrides in subsequent periods. Compare, for example, CH_4 with SiH_4. Why is CH_4 stable and inert, while SiH_4 is rather unstable and undergoes metathesis with some salts? Presumably H is joined to C in methane by covalency, while the hydrogen of silane is "ionised." Why is this so? Comparison of HF with HCl shows an analogous difference. Why is HF so weak an acid? Certainly not for lack of electronegativeness on the part of fluorine. If we are to regard HCl as always "ionised," does covalency in the case of HF gradually give place to electrovalency as its aqueous solution is diluted and specific conductivity increases, and, if so, why? Comparison of CCl_4 with $SiCl_4$ is equally interesting, because CCl_4 is analogous to CH_4 in inertness and $SiCl_4$ to SiH_4 in reactivity. Why, then, does covalency obtain with one chloride and electrovalency with the other?

These few questions point to the fundamental problem of the gradation of properties of the elements in the periodic classification; and further developments of his theory, which Dr. Langmuir promises, will be looked for with great interest.

R. M. CAVEN.

Royal Technical College, Glasgow,
September 26.

The Dushman Equation for the Velocity of a Monomolecular Reaction.

IN view of the discussion at the Faraday Society on September 28, it is perhaps of interest to direct attention to the Dushman equation for the monomolecular velocity constant (Journal A.C.S., 1921, vol. 43, p. 397). This equation, $\kappa = \nu\epsilon^{-\frac{Nh\nu}{RT}}$, where h, R, T, and ν have the usual significance and $\epsilon^{-\frac{Nh\nu}{RT}}$ represents the number of active molecules, is found to hold fairly accurately for certain monomolecular reactions that have been investigated. Of these the chief are the decomposition of phosphine and nitrogen pentoxide. Much dispute has arisen as to the meaning of ν. Is this related to the frequencies of the *activating* radiation, or is it a frequency characteristic of some degree of freedom in the decomposing molecule? Judging from the constancy of $h\nu$ over a range of temperatures, the latter would appear to be the more reasonable assumption. The relationship between ν and the absorbed and emitted frequencies would thus be left open.

On this hypothesis it is possible to ascribe a simple meaning to the Dushman equation, for the "period of existence" of the molecule in the active condition will be $1/\nu$, *i.e.* the period of time corresponding to one molecular vibration. This equation could not hold if the rate of chemical decomposition of the active molecule was in any way different from its rate of decay, due to the emission of quanta to its environment. For if there is any difference between the two rates, the position of equilibrium will be disturbed, and the number of active molecules will not be given by the Maxwell relation. In general, the time of association of an activating quantum (of a lower frequency than ν) with a gaseous molecule will be greater than $1/\nu$, so that the effect of chemical decomposition will lower the concentration of the active molecules at the steady state and decrease the velocity constant. κ would in these circumstances be less than the value obtained from the Dushman equation. Tolman (Journ. A.C.S., 1921, vol. 43, p. 269) finds for nitrogen pentoxide that κ (calc.) $= 19 \times 10^{-5}$, while κ (obs.) $= 4{\cdot}87 \times 10^{-5}$. The change in κ is thus in the required direction. The *exact* agreement obtained by Dushman in the case of phosphine would thus appear to be accidental.

W. E. GARNER.

University College, London.

The Duration of Sunrise and Sunset.

MY attention having been accidentally directed to this matter, I have made observations for the purpose of comparing the observed duration of sunrise and sunset with the duration computed from geographical position and *Nautical Almanac* data, and have now seventy-nine complete observations, made mostly with marine horizons on Manila Bay, the China Sea, the open Pacific, Vineyard Sound, and Buzzard's Bay, with a few made with land horizons. The viewpoints have been from sea-beach to 1512 metres elevation.

There seem to be two types of marine sunrise and sunset; one, type A, about twice as frequent as the other and accompanied by horizon mirage. The diagrams (Fig. 1) accompanying this letter, sketched from photographs obtained at Woods Hole, show the characteristics of the two types, which are described with historical details in *Popular Astronomy* (vol. 29,

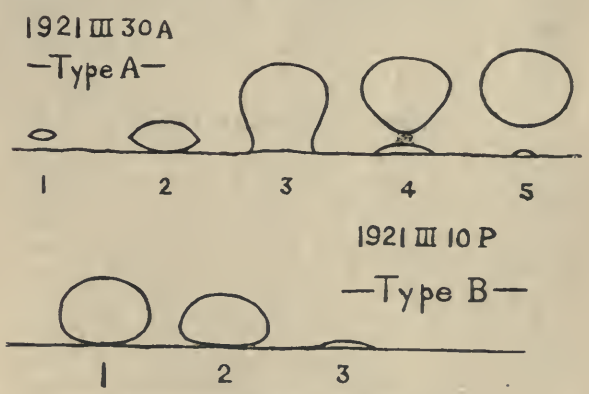

FIG. 1.—Types of marine sunrise and sunset.

pp. 251 ff., May, 1921) and, with theory and methods used, in the *Philippine Journal of Science* (vol. 17, pp. 607–14, 1920).

The time observations, made with field-glass or telescope, stop-watch, and ordinary watch, show that with type A there is, on the whole, a slight excess of observed duration over computed, amounting for forty-four cases to 0·55 per cent.; a few cases give small deficiencies. This may be, perhaps, explained by atmospheric dispersion. Type B, however, always gives excess, sometimes remarkably large, even 2 min., or 68 per cent., with an average excess for twenty-two cases of 12·3 per cent., which is difficult to explain.

Records of duration of sunrise and sunset are almost non-existent; a careful search, with inquiries of several prominent astronomers, has failed to produce more than about half a dozen, mostly made by Le Gentil at Pondichéry in 1769 while on his transit of Venus expedition. While he made no such use of them, on computing they give results in agreement with the above. It would seem, perhaps, worth while for others to take the matter up and record and publish *at least* date and hour, geographical position, nature of horizon, duration, and type or form of disc. The horizon should be quite level or distant if at all irregular. Naturally, the best horizon is that of the sea or a large lake; but I have reason to believe that the results of observing with a distant level land horizon might be sometimes quite extraordinary.

While the sun is the source of light in such observations, and the *Nautical Almanac* and four-place logarithms have to be used in the computing, the subject is not astronomical, but meteorological, and, I believe, has to do with temperature distribution in the atmosphere. We have here one of those residual phenomena the study of which may lead to the discovery of interesting facts and which can be forwarded by amateur observers, the more and the more widely scattered the better.

WILLARD J. FISHER.

Cambridge, Mass., September 14.

Is Bisexuality in Animals a Function of Motion?

IN NATURE of September 29, p. 145, Dr. Orton makes the interesting suggestion that bisexuality in animals may be causally connected with the development of a freely moving, as opposed to the sessile or sluggish, habit. Reviewing the incidence of hermaphroditism and bisexuality in the animal kingdom, he reasserts the proposition put forward by Claus that hermaphroditism is found most frequently in fixed, parasitic, and sluggish animals. The two modes of reproduction may therefore be functions of the degree of motor activity manifested by animals.

I do not wish to contradict Dr. Orton's general proposition, especially as he has framed it tentatively and without dogma. But I would like to point out that in the Mollusca we have an excellent opportunity of testing the truth of the suggestion in a single group. The streptoneurous Gastropoda are, with some exceptions, bisexual; the Euthyneura are exclusively hermaphrodite. I do not think, however, that we can select the Euthyneura as exclusively "sluggish" animals and the Streptoneura as exclusively "active." The Pulmonata (Euthyneura), with their lengthy æstivation or hibernation period, might be regarded as more sluggish than the average Prosobranch. But other Euthyneura which apparently do not æstivate or hibernate for a long period cannot be regarded as more sluggish than the Streptoneura, viz. the Tectibranchs and Nudibranchs. Having kept many of these animals in captivity myself, I can testify that they are no less active than Streptoneura observed under similar conditions. An Aplysia is not more sluggish than a Buccinum or a Paludestrina. I admit that an intimate study of the habits of all Gastropoda is not available, but the known facts go to show that many of the hermaphrodite forms are as active as the bisexual ones. Dr. Orton may reply that many of the apparently bisexual forms may be liable to intermittent hermaphroditism. I have no doubt that permanent and intermittent hermaphroditism may be commoner in the Streptoneura than we imagine, but all the evidence accumulated over many years goes to show that bisexuality is regular and very widely developed among this group. During the last two years, for example, I have examined more than a hundred examples of various species of Paludestrina and kindred genera, and not found a single hermaphrodite form. In Pelseneers's "Variations et leur Hérédité chez les Mollusques" (1920) there are only five genera cited in which occasional hermaphroditism is recorded, though doubtless Dr. Orton could add a few more to the list.

The suggestion that hermaphroditism is either the direct result of the sedentary habit or that it is in some way facultative for animals leading such a mode of life is indeed interesting. But in that case it is difficult to see why it is not found as the *exclusive* mode of reproduction among the Scaphopoda, the Lamellibranchia, and the Polyplacophora (Chitons), which are all, on the whole, more sluggish than the Streptoneura. Dr. Orton's proposition may well be true of sessile or parasitic forms, but it scarcely seems to be true of animals which are merely sluggish. It should be pointed out that great diversity of habit occurs in the various groups of Gastropoda which might on a superficial view, perhaps, be categorised as "active" or "sluggish." Along with really sluggish forms are associated species which are active swimmers, burrowers, and climbers. Finally, it might be asked whether the locomotor test is an entirely safe criterion of physiological "sluggishness" or "activity."

G. C. ROBSON.

Zoological Department, British Museum (Natural History), October 3.

An Algebraical Identity.

IN NATURE of July 21 (vol. 107, p. 652) appears a letter from Mr. W. E. H. Berwick, inquiring whether the values of y, z satisfying the equation $z^2-py^2=-4$, which are derivable from Gauss's cyclotomic formulæ, constitute generally the primitive solution of this equation. In reply I have to point out that a comparison of Gauss's formulæ (Mathews, "Theory of Numbers," p. 215) with Kronecker's formula

$$\{\tfrac{1}{2}(T+U\sqrt{D})\}^h=\Pi(1-\omega^{\rho^{2n+1}})/\Pi(1-\omega^{\rho^{2n}})$$

(Mathews, p. 253), where $T^2-DU^2=4$ is the primitive solution of this equation, T and U being positive, shows that z, y are connected with the primitive solution a, b by the relation

$$\frac{|z|+\sqrt{p}\,|y|}{2}=\left(\frac{a+\sqrt{p}\,b}{2}\right)^h,$$

where h is the number of properly primitive classes of determinant p. Incidentally, it appears that z is always positive and y negative.

R. F. WHITEHEAD.

September 20.

Consciousness and the Unconscious.[1]

By PROF. C. LLOYD MORGAN, LL.D., D.Sc., F.R.S.

Emergent Evolution.

BY general consent we live in a world in which there seems to be an orderly passage of events. That orderly passage of events, in so far as something new comes on to the scene of Nature, is what I here mean by evolution. If nothing really new emerges—if there be only permutations of what was pre-existent (permutations predictable in advance by some Laplacean calculator)—then, so far, there is no evolution, though there may be progress through survival and spread, on one hand, and elimination on the other. Under Nature is to be included the plan, expressive of natural law, on which all events (including mental events) run their course.

From the point of view of a philosophy based on science our aim is to interpret the natural plan of evolution, and this is to be loyally accepted just as we find it. The most resolute modern attempt to interpret evolution from this point of view is that of Prof. S. Alexander in his "Space, Time, and Deity." He starts from the world of common sense and science as it seems to be given for thought to interpret. In order to get at the very foundation of Nature he bids us think out of it all that can possibly be excluded short of the utter annihilation of events. That gives us a world of ultimate or basal events in purely spatial and temporal relations. This he calls "space-time," inseparably hyphened throughout Nature. From this is evolved matter, with its primary and, at a later stage of development, its secondary qualities. Here new relations, other than those which are only spatio-temporal, supervene. Later in logical and historical sequence comes life, a new quality of certain systems of matter in motion, involving or expressing new relations thus far not in being. Then within this organic matrix, already "qualitied" (as he says) by life, there arises the quality of consciousness, the highest that we know. What may lie beyond this in Prof. Alexander's scheme may be learnt from his book.

This thumb-nail sketch can do slight justice to a theme worked out in elaborate detail on a large canvas. The treatment purports to formulate the whole natural plan of progressive evolution. From the bosom of space-time emerge the inorganic, the organic, the conscious, and, perchance, something beyond. And with this successive emergence of new qualities goes the progressive emergence of new orders and modes of relatedness. The plan of evolution shows successively higher and richer developments.

Such a doctrine, philosophical in range but scientific in spirit, to which, I may perhaps be allowed to say, I, too, have been led by a rather different route—I call emergent evolution.

[1] Abridged from the presidential address delivered to Section J (Psychology) of the British Association at Edinburgh on September 9.

The concept of emergence is dealt with by J. S. Mill, in his "Logic," under the consideration of "heteropathic laws." The word "emergent," as contrasted with "resultant," was suggested by G. H. Lewes in his "Problems of Life and Mind." When oxygen, having certain properties, combines with hydrogen having other properties, there is formed water, some of the properties of which are quite different. The weight of the compound is an additive *resultant*, and can be calculated before the event. Sundry other properties are constitutive *emergents*, which could not be predicted in advance of any existent example of combination. Of course, when we have learnt what happens in "this" particular instance in "these" circumstances, we can predict what will happen in "that" like instance in similar circumstances. We have learnt something of the natural plan of evolution. We may also predict on the basis of analogy as we learn to grasp more adequately the natural order or plan of events. But could we predict what will happen prior to *any* given instance—*i.e.* prior to the development of this stage of the evolutionary plan? Could we predict life from the plane of the inorganic, or consciousness from the plane of life? In accordance with the principles of emergent evolution we could not do so. The Laplacean calculator is here out of court.

In Mind.

To come to closer quarters with our sectional topic, what do we mean when we say that this or that is "in mind"? In a well-known passage Berkeley distinguished that which is in mind "by way of attribute" from that which is in mind "by way of idea." Fully realising that this should be read in the light of Berkeley's adherence to the creative concept, one may none the less claim for it validity on the empirical plane where mind is regarded as a product of emergent evolution. The former, therefore (*i.e.* what is present in mind by way of attribute), I shall speak of as *minding*, the latter as that which is minded. The former is a character constitutive of the mind—that in virtue of which it is a mind; the latter is objective *to* the mind or *for* the mind. That which is minded always implies minding; but it does not necessarily follow that minding implies something minded.

The distinction based on that drawn by Berkeley may be expressed in another way. One may be said to be conscious *in* perceiving, remembering, and, at large, minding; that which is perceived, remembered, or minded is what one is conscious *of*. I am conscious *in* attending to the rhythm or the thought of a poem; I am conscious *of* that to which I so attend. I need not *then* be conscious *of* attending to the poem, though perhaps I may, in psychological mood, subsequently make the preceding process of attention an object of thought.

Dependence and Correlation.

On these terms what is minded is no less mental than the process of minding. But I suggest that the word "consciousness" should be reserved for that which Berkeley spoke of as "in mind by way of attribute," or, in Prof. Alexander's way of putting it, as "a quality" of that organism which is conscious in minding. Anyhow, consciousness is here in the world. Creative evolution says: Yes, here in the world, but not of the world. It acts (as *élan vital*) into or through the organism regarded as a physical system; but its source is a disparate order of being to which, in and for itself, and *an sich*, it properly belongs. It depends on the physical organism in act but not in being. Now this, I urge, is a metempirical explanation of given facts, but not an empirical interpretation of them as (in my view) science tries to interpret. And its cause should be tried before a different court of appeal from that of science. Hence under emergent evolution one uses the word "dependence" in another sense, and urges that the very being of consciousness, as a quality of the organism, depends upon (or implies the presence of) the quality of life as prior in the natural order of emergence. If we enumerate successive stages, then consciousness is a quality (4) of certain things (very complex and highly organised things) in this world. In these same things there is also present the quality of life (3), and a specially differentiated chemical constitution (2). Empirically we never find (4) without (3), nor (3) without (2); and we express this by saying that consciousness depends on (or implies the presence of) life; and that life depends on a specialised kind of chemical constitution. It is an irreversible order of dependence. But there are things, such as plants, in which we find (as is commonly held) life without consciousness; and other things, such as minerals, in which there is chemical constitution (not, of course, "the same" chemical constitution) without life. Furthermore, there seems to have been a time when consciousness had not yet been evolved; and an earlier time at which life had no existence. But this or that chemical constitution is itself an emergent quality (2) of certain things; and there was probably a yet earlier stage of evolution at which even this quality had not yet emerged—a purely physical stage (1) at which (let us say) electrons afforded the ultimate terms in relation within physical events, continuously changing under electromagnetic (and, of course, also under spatio-temporal) relations.

There is clearly nothing in the foregoing thesis which necessarily precludes the further consideration of the same events from the point of view of creative evolution. The questions: What makes emergents emerge? What directs the whole course of emergent evolution?—these questions and their like are *there* quite in place. Furthermore, as between emergent thesis and creative antithesis, Kant's "Solution of the Third Antinomy" may afford a guiding clue.

The Quality of Consciousness.

Before proceeding further certain preliminary questions must be briefly considered. First, is there progressively emergent evolution in consciousness? It is a question of cardinal importance. My contention is that such evolution obtains in both aspects, inner and outer, the one in correlation with the other. This means that interpretation under emergent evolution is applicable to mental no less than to non-mental events. In other words, there is just as much progressive emergence in the inner or psychical aspect of organic nature as there is in the outer or physiological aspect. This is the keynote of mental evolution throughout its whole range.

I regret here to depart from the conclusion to which Prof. Alexander has been led. Take such episodes in our mental life as seeing a rainbow, hearing a musical chord, partaking of woodcock, dipping one's hands into cool water. In Prof. Alexander's interpretation (as I understand it) percipient consciousness, in each case, differs only in what he speaks of as "direction." That alone is enjoyed. All further difference in one's cognitive experience on these several occasions is due to the difference in that non-mental set of events with which one is then and there compresent. Even feeling, as affective, is not itself enjoyed. Feelings are objective experiences of the order of organic "sensa." They are not in mind by way of attribute. We are conscious of pleasure and pain but are not differentially conscious *in* receiving them. Consciousness is here just compresent with certain phases of life-process. Thus, for Prof. Alexander, consciousness, alike in sensory acquaintance, in perceptive cognition, and even in feeling pleasure or the reverse, is itself undifferentiated (save in "direction"); all the differentiation is in the non-mental world (beyond us or within our bodies) which is experienced and which transmits its characters to a recipient in which the rather featureless quality of consciousness has emerged.

Consciousness and Enjoyment.

Thus far the word "conscious" is used in the broad and comprehensive sense that was almost universally accepted a generation ago. But in accordance with current usage we must now distinguish consciousness from the unconscious. I happen to regard the word "unconscious" as peculiarly unfortunate—chosen as it is on the *lucus a non lucendo* principle. But let that pass. There it is and we must make the best of it—seeking to penetrate its dark wood. Under the older and more comprehensive use, consciousness may be indefinable. As in the case of spatial or of temporal relatedness we have got down to something that we find, rather than to something that can be strictly defined. Hence one has to proceed by indicating instances that fall within the inclusive class which we so name. The position is that, in the comprehensive class which we used to comprise under the heading of conscious-

ness, it is now thought desirable to make two sub-classes—(*a*) the unconscious and (*b*) the conscious. There is call, therefore, for the indication of some criteria which shall serve to distinguish the one from the other. Here definition is required. And since the unconscious is "served with the negative prefix," it is clear that the criteria we seek must distinguish by their presence the conscious from the unconscious in which these criteria are absent. Under what heading, then, are we now to place the comprehensive class including both (*a*) and (*b*)? I suppose we may call it the class of psychical events—as distinguished from physical and physiological events. But we still want some convenient noun which we may qualify by the adjectives "conscious" and "unconscious." I borrow from Prof. Alexander, and adapt for my present purpose, the name "enjoyment." Perhaps the chief objection to the choice of this word is that it must be understood as including what is unpleasant no less than that which is pleasurable. But as I cannot find a better, and am loth to coin a worse, I ask leave to use this word "enjoyment" to include all that has the psychical character or aspect. I regard the emphasis on affective tone which it suggests as a point in its favour.

On these terms there fall within the comprehensive class of enjoyment two sub-classes: (*a*) unconscious enjoyment and (*b*) conscious enjoyment—the latter marked by certain differentiating criteria. The question now arises: Is the distinction between the conscious and the unconscious just the same as that which is often drawn between "above the threshold" and "below the threshold" (supraliminal and subliminal)? Or, if they are not just the same, is there such close and intimate alliance that we may still say that all that is supraliminal is conscious and all that is subliminal is unconscious? What I wish to suggest is that the line between supraliminal and subliminal need not be coincident with that between conscious and unconscious. There are, I believe, modes of enjoyment both conscious and unconscious in the supraliminal field. But this reopens the main question: What are the differentiating criteria of the conscious?

Criteria of Consciousness.

Ask the plain man what he means when he speaks of acting consciously and he will probably reply: "I mean doing this or that with some measure of intention and with some measure of attention to what is done or to its outcome. The emphasis may vary; but one, or other, or both, of these characterise action that I call conscious. If I offend a man unconsciously there is no intention to give offence. When a cyclist guides his machine unconsciously he no longer pays attention to the business of steering, avoiding stones in the road, and so forth." Now if this correctly represents the plain man's view, it is clear that a full consideration of his attitude would involve careful discussion of intention and of attention. This is beyond my present scope. I want to dig farther down so as to get at what, as I think, underlies his meaning, and thus to put what I have to submit in a much more general form.

I want, if possible, to get down to what there is in the most primitive instances of consciousness —*i.e.* right down to that which characterises them as such. I believe that there is always in addition to that which is immediately given (say under direct stimulation in sense-awareness) some measure of revival with expectancy, begotten of previous behaviour in a substantially similar situation. Consciousness is always a matter of the subsequent occasion, and always presupposes a precedent occasion. In other words it is the outcome of repetition; and yet, paradoxically, when it comes it is something genuinely new. But this is the very hall-mark of emergence. That is why Prof. Alexander and I speak of consciousness as an emergent quality.

Let us analyse some simple first occasion—that on which a chick behaves to a ladybird will serve. The eye is stimulated from a distance with accompanying enjoyment (*a*). The chick responds by approaching and pecking with enjoyment in behaving (*b*). There follows contact stimulation with its enjoyment (*c*); and, thereon, behaviour of rejection with its enjoyment (*d*). We have thus, as I interpret, a biologically determined but orderly sequence affording successive modes of enjoyment *a, b, c, d*. So far the precedent occasion. On a subsequent occasion there is (*a*) as before in presentative form; this is immediately given in sensory acquaintance. But (*b, c, d*) are also "in mind"—mediately or in re-presentative guise, under revival, as what Prof. Stout calls "meaning." We have therefore (under an analogy) on the precedent occasion the notes *a, b, c, d*, struck in sequence. We have on the subsequent occasion (*b, c, d*) rung up by (*a*) through a "mechanism" provided psychically and neurally in the instrument. And when the notes (*a, b, c, d*) thus vibrate together they have the emergent quality of what one may speak of as the *chord* of consciousness.

What is there, however, about this emergent chord which differentiates it from the precedent sequence of notes *a, b, c, d*? It must be something psychical in its nature. I suggest that the revival carries with it a specific mode of new enjoyment which may be called "againness"; that which affords the basis of felt recognition. There is also something equally new in expectancy. That this is (so far as our own experience testifies) a factor in the chord of consciousness is, I should suppose, scarcely open to question.

Now whereas on the precedent occasion it is behaviour unconsciously directed towards that from which stimulation arrives that determines the order *b, c, d* as sequent on *a*, on the subsequent occasion it is the "meaning" (*b, c, d*) which then consciously determines the direction of behaviour. This centering of "meaning" on that

to which behaviour was on the precedent occasion unconsciously directed is the basis of conscious reference to an object.

The characteristics, then, of a chord of consciousness are revival with expectancy and with conscious reference which anticipates, and, through anticipation (thus forestalling the event), may endorse or inhibit, the further course of behaviour. And its emergent character, as chord, makes consciousness, not merely an additive blend of constituent tones of enjoyment, but (in Browning's forcible emphasis on a wholly new quality) "a star." (Cf. *Abt Vogler.*)

I have thus far dealt with the criteria of consciousness on the lines of what I conceive to be its evolutionary genesis. I must now ask whether these criteria—revival with expectancy and reference—do not characterise what we commonly regard as conscious enjoyment in our own adult life. My own experience is consonant with the outcome of genetic treatment. And I would ask others if there is not in our current consciousness always some measure of felt "againness" carried over from the past in revival, and always some measure of "comingness" in expectancy. I would ask whether there is not, as essential to consciousness, some leaning back on previous experience, some leaning forward to that which the future has in store. Is not this what M. Bergson means (I do not say all that he means) when he speaks of consciousness as "a hyphen" linking past and future?

Levels of Psychical Integration.

In our normal life much integration proceeds on the reflective level—that of rational thought and volitional conduct. The older philosophers, with some variation of terminology, urged that the difference between this reflective level and the perceptive level below it (*e.g.* in Descartes's animal automatism) is one not only of degree but of kind. The difference, they said in effect, is radical and absolute, demanding metempirical explanation. Thus the word "kind" carried a definitely metaphysical implication the influence of which is still with us to-day. But apart from this, as a matter of frankly empirical description of what is found, it was their way of expressing what I seek to express by saying that reflective consciousness has a new emergent quality—that which characterises reason as distinguished from perceptual intelligence. We have, however, the one word "consciousness" for both these levels. But within the more comprehensive sub-class, comprising all instances of consciousness, we may distinguish two sub-classes subordinate therein, (i) that of instances of reflective consciousness, and (ii) that of instances of non-reflective consciousness. Both sets of instances have the criteria of consciousness. But in (i) there is a further *differentia* in that "value" (in the technical sense) is referred to the object of such reflective thought. There is then, on this view, reflective integration, and there is also non-reflective or perceptive integration, each on its appropriate level, and each in its distinctive way conscious.

In dealing with the supraliminal field it seems to me imperative to distinguish according to the mode of origin of the integration that obtains therein. We must ask: How far is the "form" which it assumes (iii) the outcome of reflective integration; (ii) the outcome of unreflective or perceptive integration; and (i) the outcome of the integration in the subliminal unconscious to which as living beings we are heirs? If I am right in regarding (ii) and (iii) as successively emergent qualities of consciousness there is somewhat of a leap (though no breach of continuity) from (i) to (ii), and from (ii) to (iii). There is always something more (involving new terms in new relations) in the higher-level conclusion than is contained in the lower-level premises. This is the cardinal principle of all emergent evolution. Without this there would be nothing really new—merely a reshuffling of the old.

Are there Unconscious Images and Ideas?

In the interpretation to which I have been led unconscious enjoyment (not necessarily involving unconscious images and ideas) is no less integrated than is the system of physiological events which gives to life its emergent quality. If the analogy be permitted, just as in the physiological symphony of life there are chords and phrases and motifs, each with an emergent character of its own (*e.g.* the part played by the instruments of the reproductive sub-system), so too, in the psychical symphony of unconscious enjoyment there are correlated chords, phrases, and motifs. And all goes well so long as due balance and harmony are maintained in the orchestral performance, no matter what instruments play a dominant part at the time being. But unconscious enjoyment is primarily inherited psychical music correlated with the outcome of life-inheritance. I entertain little doubt that the life of animals, could we only feel its inner aspect as they themselves do, is brim-full of a rich music of unconscious enjoyment. As I write the swifts are wheeling and shrilling in the summer air. Am I wholly wrong in imputing to them an integrated form of enjoyment which is theirs on a basis of inheritance? Perhaps even sympathetic naturalists fail adequately to realise to what extent in animals the business of life as such, with further life as its wage, has also its psychical reward in enjoying so fully the performance of life's job. And this reward in the enjoyment of doing is inherited with the ability to do. A behaviourist interpretation of how it all comes about is, I believe, perfectly sound in its way. Not in what it emphasises, but in what (among extremists) it ignores—a psychical factor—does it seem to me to be deficient. In us at any rate the presence of enjoyment is undeniable. And though it is so readily caught up into consciousness it still carries, I think, the marks of its unconscious origin.

What does the poet or the artist tell us? Does he not claim that what springs up within him—if it be in truth (he may add) in any valid sense *his*—is quite inexplicable on what he regards as psychological principles? And if psychological principles deal only with conscious integration he is right. His poetry, or his art, is not in its essential nature the outcome of perceptive or reflective integration. Its well-springs lie deeper than that in the unconscious. He rightly affirms that the real thing in all true art is beyond his conscious control, though the means by which it is expressed must be learnt and may be bettered by taking thought. This is enshrined in the proverb: *Poeta nascitur non fit.* And even of those who can only appreciate his work, may it not be said, with a touch of paradox, that enjoyment in art becomes reflectively conscious in criticism? This need not mean that the critic enjoys poetry any the less for the combination in higher integration of unconscious and conscious enjoyment. What it does mean is that the glad newness and glory of surprise lies in the poetry and not in the criticism. Once again it must be said that it is the fresh unexpectedness that is still the hall-mark of the unconscious.

The Age of the Earth.

ALTHOUGH it cannot be claimed that the joint discussion on the "Age of the Earth," at the meeting of the British Association at Edinburgh on September 13, led to the complete reconciliation of the views of the various sections of the Association represented, there could be no doubt concerning the extraordinary interest taken in it. Members desiring admission overtaxed the capacity of one of the largest lecture theatres in Edinburgh, and shortly after the all too short discussion one might overhear in the streets of the city the remark, "They haven't settled it yet." It was quite evident that it was a good thing, if merely for the dissemination of modern views on the subject, that authoritative representatives of each science should address the same composite audience of physicists, geologists, biologists, and many who would claim none of these descriptions.

It was not surprising that the starting point of all the speakers was the inadequacy of Lord Kelvin's estimate of twenty million years for the age of the sun. Lord Rayleigh, whose lucid opening of the discussion will long be remembered, evidently believed that Kelvin had covered his estimate sufficiently with the proviso concerning sources of solar energy other than gravitation. Such sources, *i.e.* radio-active materials, Kelvin was unaware of, but we now know them to exist in the earth, and must presume them also to exist in the sun. Lord Rayleigh proceeded to develop his argument for arriving at the age of uranium-bearing rocks from considerations of the uranium-lead and helium which they now contain. The order and rate of radio-active disintegration through the series from uranium to lead are known with considerable precision; helium also is evolved at a definite ascertained rate. An examination of the amount of lead now present in uranium minerals enables the time when disintegration commenced to be specified, for the lead in the rocks in question proves to be not ordinary lead but wholly that isotope of atomic weight 206 which is necessarily associated with the decay of uranium. Thus broggerite found in the pre-Cambrian rocks at Moss, Norway, contains lead of atomic weight 206·06; the lead-uranium ratio is 0·113, and this points to an age of 925 million years, upon the assumption that uranium and its products have always decayed as they do now. Estimates of age can also be made by measuring the content in rocks of that other product of disintegration—helium—although leakage of this gas makes the calculation less reliable. Allowing for this, however, the indications by helium content are generally confirmatory of those given by the lead-uranium ratio. These methods can be applied to younger formations of rocks, thus obtaining the approximate age of each.

Lord Rayleigh pointed out that Prof. H. N. Russell, by applying the argument statistically to the earth's crust as a whole, arrived at the period 8×10^9 years as an upper limit—this being six times longer than that of any individual rock yet examined. He concluded by giving a period amounting to a moderate multiple of 1000 million years as the probable duration of the earth's crust in a condition suitable for the habitation of living beings. The radio-active investigations leading to this conclusion are supported by other physical and astronomical evidence.

Prof. Sollas, who followed, made merry on behalf of the geologist, "newly enriched" from a "bankrupt" with a "mere score of millions of years" to a "bloated capitalist—with more millions in the bank than he knew how to dispose of." Within broad limits, he said, geologists were ready to leave to the physicists the precise calculation of geological time. Some geologists, notably the brilliant and lamented Barrell, had already begun to rebuild their science on the magnified scale. For himself, he preferred first "to make sure that the new radio-active clock was not as much too fast as Lord Kelvin's was too slow." In this connection Prof. Sollas directed attention to Prof. Joly's examination of the "pleochroic haloes" occurring in uranium-bearing black mica. These haloes, which are formed by the α-rays expelled by uranium in the various stages of its disintegration, are found generally to have ranges consistent with those obtaining in modern times. The two inner rings, however, form a notable exception, indicating ranges greater than normal

by one-sixth, and Prof. Joly's conclusion is that in Caledonian times there existed a metope of the uranium which we now know, with possibly very different properties. If this is true, the uranium clock has not been keeping uniform time, and the true age of the earth cannot be found by presuming that it has done so.

Prof. Sollas proceeded to explain and criticise the arguments whereby geologists are seeking to modify estimates of age based upon sedimentation, sea salinity, and denudation, so as to bring them more in accordance with radio-active and other physical calculations. He evidently considered these modifications not only premature (for reasons given earlier), but to some extent unsound. Geologists, he said, are not an undivided family, and proceeded to dissent, in anticipation, from the views of Prof. J. W. Gregory, read afterwards in abstract, owing to his regrettable absence, by Prof. Jehu. The necessity for modification of the hundred million years or so, based on the original salinity argument, was stated by Prof. Gregory to be due to certain omissions and untenable assumptions. It was assumed that the sea was originally fresh, although the oldest fauna, the Cambrian, has marine characteristics, and no allowance was made for large supplies of sodium chloride raised by magmatic waters from beneath the earth's surface. Denudation also was supposed to be uniform, although it was very improbable that this had been the case. The earth is now under the influence of a time of quick movement, whereas formerly it had alternated between times of repose and activity, owing to deformations which it had undergone. (One cannot refrain from quoting Prof. Sollas's comment that "we must no longer picture a time when the earth was 'young and wantoned in her prime,' but must suppose that she has exchanged the passive indolence of youth for the fiery activity of old age.") Altogether Prof. Gregory considered that the best-known geological estimates might safely be multiplied ten- or twenty-fold, thus bringing them into line with the physical evidence.

Prof. Eddington brought forward interesting evidence based on astronomical observations. He described the observed behaviour of certain variable stars, of which δ Cephei is a typical example, in which there is strong reason for supposing that the fluctuations of intensity are due to some intrinsic property of the star, and not to external influence. The observed change of period (itself a few days) of δ Cephei has been proved by a long series of measurements to amount to 0·08 sec. per annum, or 1 per cent. in 58,000 years. If the periodicity is associated with "pulsation" of the star it will be related also to the density in such a manner that the density of the star is changing at the rate of 1 per cent. in 29,000 years. From considerations of the luminosity of the star—a red "giant"—it would require an increase of density at the rate of 1 per cent. in *forty years* to provide the necessary energy according to Lord Kelvin's gravitational contraction hypothesis. We may conclude (1) that the star certainly has sources of energy other than gravitation, and (2) that Lord Kelvin's time scale should be lengthened in the proportion 29,000 : 40, or about 700 : 1, at least during this stage of its evolution. A considerable factor of the same kind would be required for the sun also, even though its evolution has progressed much further, so that it is now a "dwarf" star.

Owing to lack of time it was not possible for Dr. H. Jeffreys to take a verbal part in the discussion, and his remarks were communicated afterwards. Dr. Jeffreys's calculations are based upon two distinct considerations: (1) the temperature distribution downwards in the earth's crust, taking into account the radio-active content; and (2) the tidal theory of the origin of the solar system. It is not possible to do them justice here, but we propose to publish them in a later issue. Both theories lead to the estimate of approximately 2×10^9 years since the solidification of the earth's crust, which is in remarkable agreement with the results of other physical methods.

Sir Oliver Lodge, in a few words at the end of the discussion, pleaded for justice to Kelvin, whose calculation specifically assumed that "no source of energy other than gravitation existed." But Dr. Dear, with a rare eloquence which delighted the audience, would not let the matter rest there, but asserted that Kelvin arrived at his twenty-million-year estimate by three distinct methods, and regarded it as unalterable.

In closing the discussion the president, Prof. O. W. Richardson, laid stress upon the necessity for further careful experiments for the final elucidation of the problem.

The Constitution of Molecules.

THE joint discussion on the "Constitution of Molecules" by Sections A and B of the British Association aroused great interest, and the audience, which filled the large meeting room to its utmost capacity, included many visitors from other sections. Dr. Irving Langmuir introduced the subject with a clear and attractive presentation of the theory which is associated with his name and with that of Prof. G. N. Lewis. As originally published, this theory depended on a rather large number of arbitrary assumptions, but it has since been greatly simplified, and now involves only the three postulates described in NATURE of September 15, p. 101. The first of these postulates, according to which the electrons arrange themselves in the atom in definite layers of 2, 8, 8, 18, 18 and 32, is sometimes in conflict with the third, which requires that the residual charge on each atom and group of atoms should tend to become a minimum, and by giving greater weight to

one or to the other it is possible to bring the majority of compounds within the scheme. This possibility, whilst making it easy to find an explanation for a variety of facts, is an obstacle to the establishment of the theory on a firm physical basis. However, Dr. Langmuir is engaged on the quantitative examination of the consequences of the suggested distribution of electrons, and the progress made since the original publication in 1919 is so great that a still closer approximation to chemical facts may be expected with some confidence. One theoretical prediction, that of the salt-like character of lithium hydride, was mentioned as having been confirmed by experiment, and this confirmation is of some importance.

Unlike the Bohr atom, which is based mainly on the physical study of radiation, the Langmuir atom finds its chief justification in its power of accounting for chemical facts, and its presentation is almost entirely non-mathematical, so that it should make a special appeal to chemists. However, the discussion which followed the opening address approached the subject mainly from the point of view of physics and electro-chemistry, few chemists having yet considered in detail the bearing of the theory on organic or structural chemistry. The awakening of a greater interest in the subject of valency among chemists is likely to be one of the most useful results of the discussion, since the unsatisfactory position of the existing theories is well known, especially in regard to inorganic compounds, and the difficulties have usually to be evaded rather than met in the presentation of the subject. On Dr. Langmuir's view, it is incorrect to write structural formulæ for inorganic compounds such as salts, acids, or silicates, by using the same system of bonds as for organic compounds, electro-valency, which is represented by an electron passing from the sheath of one atom to that of another, being essentially different from co-valency, represented by the sharing of a "duplet" of electrons by two atoms. This distinction is an important feature of the theory, and is very ingeniously applied in the explanation of the structure of molecules of diverse kinds.

Prof. Smithells, whose interest in the matter is that of a chemist, exhibited a series of models of atoms and molecules which went far to make the suggested arrangements of electrons clear to the audience, models or photographs of models being almost essential to an elementary explanation. Prof. W. L. Bragg showed how the X-ray analysis of crystal structure leads to the result that each atom may be regarded as occupying a sphere of measurable and constant radius, a conclusion which is entirely in harmony with the structure of the Langmuir atom. On the other hand, he mentioned new evidence of an important character, derived from the diffraction of homogeneous X-rays by atoms. As X-ray analysis may be used to determine the position of atoms in a space lattice, so a further refinement of the method leads to conclusions as to the arrangement of the electrons within the atom. The results appear to show that most of the electrons are clustered together in the inner portion of the sphere occupied by the atom, that is, close to the nucleus, whereas the Langmuir structure, as at present assumed, requires that the number of electrons should be greatest in the outer shells.

Another difficulty arises from the static character of the Langmuir atom. Prof. Partington brought forward evidence from the molecular heats, which may be derived theoretically from a dynamic atom of the Bohr type, but are inconsistent with the arrangement which has been adopted to account for chemical valency. Sir Oliver Lodge, however, welcomed the remark of Dr. Langmuir that a static arrangement was not a fundamental condition of the theory, and suggested that chemists and physicists would find a dynamic atom the most suitable for the explanation of both classes of phenomena. A way out of the difficulty was suggested by Dr. E. K. Rideal, his view being that the atoms might be regarded as static except during the actual emission or absorption of energy, oscillation of the electrons under those conditions being more probable than rotation. Members of an assemblage of apparently like molecules differ in reactivity, this difference being attributed to an alteration of the position of one of the valency electrons relatively to the nucleus. This view awaits experimental confirmation.

Direct evidence in favour of the theory was produced by Prof. Rankine from experiments on the viscosity of gases. These lead to values for the dimensions of the chlorine molecule, for instance, corresponding with two argon atoms with their outer electron shells contiguous, and to similar relations between bromine and krypton, and between iodine and xenon. Further, on the assumption of the Langmuir structures, methane bears to ammonium the same relation as krypton bears to rubidium. Rubidium and ammonium are known from crystallographic evidence to have nearly equal molecular volumes, and an atom of krypton should therefore have the same volume as a molecule of methane. Determinations of viscosity prove this to be the case. Dr. S. H. C. Briggs gave reasons for writing elements as compounds of a nucleus with electrons, and for applying the ordinary type of equation for dissociation and similar reactions to elements as well as to compounds.

In the informal discussions which took place among members of Section B after the meeting it was possible to learn something of the attitude of chemists towards the theory. The distinction between electro-valency and co-valency is valuable, and the harmony between the new conceptions of the grouping of atoms and that of the space lattice in crystals is very attractive. The least satisfactory aspect of the theory is seen in its application to carbon compounds. The tetrahedral arrangement of the carbon atoms, confirmed by the X-ray analysis of the diamond, has not only accounted with wonderful success for the known facts of organic chemistry, but also has

proved itself invaluable in predicting new facts, so that it has now established itself in an almost impregnable position. Dr. Langmuir's atom, although presenting a tetrahedral aspect, is less able to adapt itself to organic compounds. A single bond, in the ordinary notation, is represented by an edge common to two cubes, a double bond by a face in common, so that an entirely different structure has to be adopted for a triple linking, and acetylene becomes one of the puzzles of the theory. It was also remarked that the model of sodium carbonate was essentially similar to that proposed by Werner, suggesting that the co-ordination theory might be elaborated to explain many chemical facts in place of a new hypothesis. It is probable that the study of valency will receive much attention in the near future, and that chemists will test each hypothesis thoroughly in its application to structural chemistry, which rests on an enormous mass of definitely established facts, with which a theory must be able to deal. In the meantime, the scheme of Dr. Langmuir, so clearly presented on this occasion, forms an excellent basis for discussion, and the Edinburgh meeting has served a most useful purpose in focussing attention on the difficulties, as well as on the advantages, of the proposed solution of the problem.

The Study of Bird-migration by the Marking Method.

THOUGH many valuable contributions have been made in recent years to our knowledge of the various phenomena associated with bird-migration, yet much remains to be accomplished.

One of the most important desiderata is to obtain definite information of a detailed nature as to the provenance of the migrants which arrive in spring, let us say, in the British Isles, and are widely or more or less locally distributed during the summer, and equally, or more widely, dispersed in their winter retreats. The same remarks apply to the numerous winter visitors: In what particular areas have they passed the summer? Do, for instance, redwings from Iceland winter with us as well as redwings from their wide-ranging summer haunts in Europe? Whence come the hosts of birds-of-passage which traverse our isles in spring *en route* for summer haunts in more northern lands, and return in the autumn on their way to their accustomed winter quarters? Each species comprised in these three groups of migrants is in all likelihood widely dispersed at both seasons, but as yet our knowledge is infinitesimal as to where the summer visitors to our country pass the winter, or where our winter visitors pass the summer, and we know nothing regarding either the summer or the winter haunts of the passage migrants.

In addition, more definite information is desirable as to (1) the routes followed by birds to reach their seasonal haunts; (2) whether the young seek the same summer and winter quarters as their parents; and (3) the winter retreats of the migratory section of certain British birds—the so-called partial migrants.

The difficulty in solving these important problems may fairly be described as insurmountable *in the main*; but it has been proved feasible to obtain glimpses of enlightenment, and it is most desirable to add to these glimpses, which, when correlated, become important. This may be accomplished in detail by the process called "ringing," and in its broader aspects through a knowledge of the distribution of racial forms, *if* such forms are based on well-marked characters. The ringing method is, however, the more promising, since the data so obtained are of a definite nature; and all who have the opportunity should cordially co-operate in forwarding the researches on these lines which are now being carried out.

With this end in view the University of Aberdeen instituted, in 1910, an inquiry for "The Study of Bird-migration by the Marking Method." This work was carried on for several years as a piece of research under the general direction of Prof. J. Arthur Thomson, to whose son, Dr. Landsborough Thomson, on whom the carrying out of the investigation devolved, we are indebted for the "Results," which were recently published in *The Ibis*. The total number of species ringed was about 100, and the number of individual birds 27,802. The total number of "reappearance records" (recoveries) was 879, or 3·2 per cent. But, as in other inquiries of a similar nature, many of the recoveries, as was to be expected, were made in the vicinity of the scene of marking, and after an insignificant period of time. Information of an important nature was obtained, some of which forms a valuable contribution to our knowledge of the seasonal distribution abroad and at home of the following species—namely, the lapwing, woodcock, starling, song thrush, swallow, hedge-accentor, mallard, herring gull, and blackheaded gull. The data regarding these have been carefully analysed and studied in all their bearings, and the deductions derived therefrom are given in detail. Regarding the rest of the species discussed, thirty-five in number, the data are not considered sufficient for such elaborate treatment, and for these brief summaries are given which afford in some cases records of considerable interest. There are also useful sections in which are discussed the purposes of bird-marking, its history, the interpretation of results, conclusions regarding bird-migration, and the value of the method of ringing, all of which are well worthy of perusal.

The University of Aberdeen is to be congratulated on its enlightened action in fostering this special piece of research, which, thanks to the labours and skilful treatment of one of its *alumni*, backed by the assistance of a number of enthusiasts, also *alumni*, has, greatly to his credit, been brought to a successful issue. W. E. C.

Obituary.

WE regret to see the announcement of the death, at the ripe age of eighty-three, of MR. JOHN THOMSON, a well-known pioneer in the application of photography to the furtherance of geographical knowledge at a time when the photographer depended for success on his own skill rather than on the improved appliances which have since put the art within the reach of every amateur traveller. Mr. Thomson started for the Far East in 1862, and, after residing for a time at Singapore, in 1865 undertook the first of his more ambitious journeys, which took him to the interior of Cambodia, where he secured excellent pictures of the wonderful antiquarian remains lying buried in the tropical jungles, particularly at Nakhon Wat. Under the title "The Antiquities of Cambodia" he published in 1867 a selection of these photographs in book form, with descriptive letterpress, thus making those imposing ruins first generally known to the British public. Later he extended his wanderings to China, both visiting many of the ports and making trips into the interior, one of which took him up the Yangtse beyond the gorges of its middle course. In 1873 he issued an extensive series of photographs, illustrative of China and its people, in four folio volumes. Two years later he published a general narrative of his "ten years' travels, adventures, and residence" in the Far East. Once more, in 1878, he made use of his camera for the illustration of a country more or less off the beaten track —this time the island of Cyprus—on which he issued an illustrated work in two quarto volumes in 1879. When, about this time, a scheme of instruction for intending travellers was set on foot by the Royal Geographical Society, Mr. Thomson, who had become a fellow of the society in 1866, was put in charge of the instruction in photography, for their proficiency in which many travellers have been largely indebted to his valuable hints. At his studio in Bond Street he had the privilege of taking the portraits of many distinguished modern travellers, and he extended his collection to those of earlier times by photographic reproductions of existing portraits.

WE announce with regret the death of DR. JOHN WARD COUSINS on September 22 at the age of eighty-seven years. Dr. Cousins received his medical training at St. Thomas's Hospital, and proceeded to the degree of M.D. (Lond.) in 1859. In the following year he became a fellow by examination of the Royal College of Surgeons, and after a short time at hospital practice devoted himself entirely to surgery. In connection with this work he quickly made himself prominent by the numerous inventions and improvements in surgical instruments which he devised. His ingenuity received its reward in 1884, when he was awarded a prize by the British Medical Association and a gold medal by the International Inventions Exhibition. His administrative powers found scope from 1893–95, when he was president of the Central Council of the British Medical Association, and in 1899, on the occasion of the Portsmouth meeting of the association, Dr. Cousins was elected president.

SIR JAMES DIGGES LA TOUCHE, whose death at Dublin is announced, belonged to an old Anglo-French family, and was a member of the Indian Civil Service for forty years before his retirement in 1907. At the close of a successful official career he was appointed to the post of Lieutenant-Governor of the United Provinces of Agra and Oudh, and to a seat on the Council of India. He was a typical civilian of the older school, hard-working and devoted to the interests of the Indian people, but lacking that breadth of view which would have qualified him to meet the new political conditions which arose after his retirement from the Service. Though he knew the people intimately, he possessed little imagination or literary skill, and he published nothing except a gazetteer of the Province of Ajmir. His memory will be preserved by his educational policy—the improvement of the teachers' position, the provision of improved school buildings and boarding-houses, and, finally, by his foundation of the Medical College at Lucknow, which was the crown of his official labours.

THE death is announced of PROF. GUSTAV MANN at Tampico, U.S.A., on July 18, at the age of fifty-seven years. Prof. Mann's vivid personality will be best remembered by Oxford physiology students of twenty years ago, and his translation to the chair of physiology at the Tulane University, New Orleans, was a grievous loss to the progress of histology in this country. As a master of the technique of his subject he was probably unsurpassed, and his breadth of view and lively imagination gave his instruction an unusual interest and significance, carried on by his pupil and successor at Oxford, S. G. Scott, until the latter's premature death. Too volatile to be largely productive in the ordinary way, his "Physiological Histology" is often the most thumbed book in laboratories where section cutting is taken seriously, and many grateful pupils will lament a real master whose determination to get himself disliked led him into so many troublous adventures.

WE much regret to announce the death, in his eighty-third year, of PROF. JULIUS VON HANN, for many years director of the Zentralanstalt für Meteorologie und Geodynamik, Vienna.

Notes.

WITH regard to the article on "University and Civil Service Salaries" published in our issue of August 25, the editor of the *Civil Service Gazette* has written to say that "the proportion of Civil Servants receiving above 500*l.* per annum is relatively very small, whereas the number of teachers receiving this amount all over the country is decidedly large." The latter part of this statement, we may say, even if it were true, is quite beside the point. That a large number of teachers all over the country should receive more than 500*l.* per annum does not make the lot of a large number of university teachers who receive less than 500*l.* per annum any better or more endurable. It may be recalled that the article arose out of a letter (and subsequent correspondence) from the Provost of Worcester College to the *Times* of August 15. This letter stated, *inter alia*, that many Civil Servants receive double, and even treble, the salary that the greatest learning and distinction can obtain at Oxford, and this notwithstanding that, with few exceptions, Civil Servants of the highest class are men whose intellectual attainments, as tested in examinations, fall considerably short of the standard of a tutorial fellowship at Oxford. If, therefore, any comparison of emoluments is to be made, it should not be as between university teachers and the whole body of the Civil Service, but as between university teachers and Civil Servants *of the highest class*. When this is done we find, as stated in our article, that the emoluments of university teachers fall considerably below those of this class, and we mentioned the modest 800*l.* a year of a tutorial fellow of Oxford, and referred to the fact that the permanent heads of Government Departments after September 1 will receive "only" 3000*l.* a year—as one of the *Times* correspondents quaintly puts it. Whether Civil Servants of the highest class are overpaid or not is a question which we did not discuss. But we had no hesitation whatever in asserting that, in view of such salaries, University teachers—who are public servants no less than the Civil Service—are grossly and unfairly underpaid.

OCTOBER weather this year has created a record which has outstripped the many weather records of 1921. Each day of the first week was extremely warm. The *Times* of October 6 contained a communication on the "Warmest October day on record." Descriptive of October 5 it gave shade temperatures of 84° at Kensington Palace and Camden Square, 83° at Kew Observatory and Hampstead, 82° at Croydon, Bath, Weston-super-Mare, and South Farnborough. At Camden Square so high a reading had not previously been reached in October during a period of sixty-four years. At Kew the reading was the highest October reading in fifty years, and 6° above the previous maximum in October, 1886. On October 6 the temperature was 84° at Kensington and Hampstead, 83° at Croydon, and 82° at Kew. Temperatures of 80° and above occurred this year at Greenwich on four days between October 1 and 6, the reading was 83·3° on October 5, and 84·4° on October 6. The average maximum for the early days of October is 60°. There was only one day in September warmer than October 6, 87·9° on September 9, and there was no day so warm in August this year. In the previous eighty years, since 1841, there had been only one day in October with a shade temperature so high as 80°, the thermometer registering 81° on October 4, 1859. In 1908 there were four days, October 1–4, with the thermometer at Greenwich above 75°, the first three days each having a temperature of 78°. This is the nearest approach in October to the hot spell just experienced. In the eighty years there have been fifty-seven Octobers with the maximum for the month less than 70°, and two Octobers with the maximum less than 60°. During the night of October 3–4 the lowest temperature in parts of London was 64°. In the previous eighty years at Greenwich the thermometer has only once remained above 60° throughout the night, the highest night minimum being 60·3° on October 6, 1916. In Paris the temperature of 82·8° last week is stated to have been the highest recorded in October since 1757.

ANNOUNCEMENT is made in the *Times* of October 6 that a flashless and smokeless powder has been produced by the Ordnance Corps of the United States army, and that the flameless effect is obtained by mixing certain substances with the propellant so that a dull red glow, instead of a flame, is produced at the muzzle of the gun. The subject of flamelessness in artillery is one which presents difficulties, both as to its tactical advantage in all circumstances—for when the round is flameless there is usually a certain amount of smoke—and also as to achieving the condition in guns of all calibres. An advantage of a flameless explosive is the reduced liability to backflash on opening the breech of the gun. The subject has been studied photographically for a number of years in connection with the liability of blasting explosives to ignite fire-damp in mines, and Will showed by this method that the addition of salts, mostly of the alkaline metals, to blasting explosives suppressed the after-flame of the explosion, not only from explosives such as the carbonites (mixtures of nitroglycerine, nitrates, and oxidisable substances), but even from trinitrotoluene and picric acid. According as the mixture of gases evolved from the explosion, containing inflammable gases such as carbon monoxide and hydrogen, does or does not ignite on mixing with the air at the mouth of the bore-hole, so the explosive gives flame or is flameless. The same principle has been applied to the burning in a gun of propellants of suitable calorimetric value, and for calibres up to five inches mentioned in the *Times* report flamelessness can be attained without much difficulty. To solve the problem for larger guns is, however, by no means so easy.

IN his address on October 3 to the newly constituted Glasgow Society for Psychical Research Sir Oliver

Lodge gave an interesting exposition of his view of the æther of space as a region of possibilities in contrast with matter as a region of facts. Following Bergson's theory that memory is a purely spiritual fact which does not depend on the brain for its existence, but requires the intervention of the brain for its expression, and that mind generally, though itself psychical and not physical, needs and uses matter as its instrument, he argued that if mind when dissociated from matter continues to exist, it can only be that there is something else which can perform the function of matter and serve as its instrument. For himself he has told us he is convinced that disembodied spirit personalities do exist in fact, and therefore for him it would seem the æther is a necessary postulate. His acceptance of the principle of relativity does not apparently in the least affect his belief in the real physical existence of the æther; it seems only to have added a few more negative qualities to that exceedingly elusive stuff and made its residual positive reality more than ever difficult to imagine. Still, perhaps the new society may succeed where Michelson and Morley failed, for psychical research, as Sir Oliver conceives it, is purely and essentially physical research, however suspect to some of us its methods may appear.

LORD GREY OF FALLODON has always been a keen supporter of all legislation for the protection of wild birds. A great believer in "sanctuaries" for birds, he has done much on his own estate to shield all species which have chosen to settle there. His success with various species of wild birds he related in the course of a most delightful address given on October 6 to the Berwickshire Naturalists Association. From the strictly scientific point of view, there were many items of more than passing interest in this address. Particular attention, for example, was directed to the fact that among the Anatidæ, where the males lose their resplendent livery and go into "eclipse," they take no interest in their offspring, which have to be reared by the female alone. But where no "eclipse" dress is worn they prove devoted parents, taking their full share in the task of tending the young. That the various species of wild ducks, when in a state of Nature, are monogamous seems conclusively proved by their behaviour at Fallodon, wherein they contrast with birds of the same species in captivity.

SIR FRANK DYSON, Astronomer Royal, has been elected master of the Clockmakers' Company.

THE G. de Pontécoulant prize of the Paris Academy of Sciences has been awarded to Dr. A. C. D. Crommelin, Royal Observatory, Greenwich, in recognition of his general astronomical work.

MR. A. CHASTON CHAPMAN has been appointed a member of the Royal Commission on Awards to Inventors in succession to Sir James Dobbie, who has resigned.

A DINNER will be held at the Hotel Cecil on Tuesday, October 25, to celebrate the purchase of the Brent Valley Bird Sanctuary, and to make known the need of funds for its upkeep and endowment. The Right Hon. Viscount Grey of Fallodon, K.G., will preside. Tickets may be obtained from the honorary secretary at the Hermitage, Hanwell, W.7.

THE Royal Society of South Africa proposes to entertain the members of the Shackleton Expedition when they arrive in Cape Town. The society has entertained previous expeditions, and at a recent meeting the president expressed the hope that the forthcoming visit would arouse public interest in South Africa in scientific exploration and would lead to additional support for such enterprises.

IN the article on the explosion at the nitrogen fixation works at Oppau, in NATURE of September 29, it was pointed out that ammonium nitrate is explosive on the application of an intense initial impulse such as the detonation in its midst of a high explosive. It is, therefore, of interest to read in the *Chemical Trade Journal* (October 1, p. 409) that the directors of the Badische Anilin und Soda Fabrik have issued a report in which they state that a store of ammonium sulphonitrate exploded, and that it had been the custom to break up the stock of this mixture by means of explosive bodies. Until now the directorate had apparently considered the ammonium nitrate sufficiently deadened by the presence of the ammonium sulphate.

A MESSAGE from Col. Howard Bury to the *Times* states that a practicable route to the summit of Mount Everest has been discovered. A camp was formed at the col at the head of the Kharta Valley at a height of 22,500 ft., and Messrs. Mallory, Bullock, and Wheeler pushed on to the glacier below the north col on the following day. The north col, which connects Mount Everest with the north peak, was ascended to a height of 23,000 ft. At this point the party was stopped by bad weather, but it is believed that an ascent by the north-east *arête* will be possible. The reconnaissance of the approaches to Mount Everest from the Tibetan side is now complete, and, a route having been found, there appears to be no reason why a properly organised expedition should not reach the summit next year.

THE ninth meeting of the Indian Science Congress will be held in Madras on January 30–February 3, 1922. His Excellency Lord Willingdon, Governor of Madras, has consented to be patron of the meeting, and Mr. C. S. Middlemiss will be president. The following sectional presidents have been appointed:—Agriculture, Rai Bahadur Ganga Ram; Physics and Mathematics, Mr. T. P. Bhaskara Shastri; Chemistry, Dr. N. R. Dhar; Zoology, Mr. S. W. Kemp; Botany, Dr. W. Dudgeon; Geology, Mr. G. H. Tipper; Medical Research, Major Cunningham; Anthropology, Rai Bahadur Hira Lal. Public lectures will be delivered by Prof. Hemchandra Das Gupta, Dr. de Graaf Hunter, and Prof. J. Matthai. Capt. C. Newcomb, Khan Sahib Mohammad Azizullah, and Sahib Bahadur have been appointed honorary local secretaries. Further information can be obtained on application to Dr. J. L. Simonsen, the honorary general secretary.

THE members of the British Association had, during their recent visit to Edinburgh, an opportunity of examining the remarkable hoard found in 1819 at Taprain Law, a conical hill nearly midway between Haddington and Dunbar. The excavations were carried on by the Society of Antiquaries of Scotland, to whom Mr. Balfour, the owner of the land, generously presented all that was found, which is now exhibited in the Scottish National Museum. It is almost certain that this great collection of silver plate was a robbers' hoard. Some of the objects are plainly Christian, others pagan, with traces of Oriental decoration. The Saxons were notorious sea-raiders, while the native Celts were not, and the hoard possibly consists of plunder from churches or private houses somewhere on the Continent. It may be assumed that the *cache* was made about 1500 years ago, and the raiders who buried it were probably interrupted by the approach of another and stronger force, leaving the treasure to be unearthed by excavators in our time.

IN the Journal of the Bihar and Orissa Research Society for March, 1921, Dr. W. H. R. Rivers discusses the origin of that remarkable custom of marriage, peculiar to the Rajputs, known to anthropologists as hypergamy. Under this system a man must take his wife from a group of equal or lower rank than his own, while a woman must marry a man from a group of equal or higher rank than her own. He suggests that it arose as the result of the influence of certain conditions operating in the case of the occupation of a country by a race of warriors—a sentiment among the invaders against the union of their women with the indigenous inhabitants of their new home; the fact that many women, but in numbers smaller than those of the men, accompanied the invaders; the warlike character of the invaders, and their superiority in equipment over the indigenous people, which allowed them to satisfy their own desire for union with the indigenous women without giving their own women in return. The first of these conditions was probably the most important. The institution became specialised among the Rajputs because among the other immigrant race, that of the Brahmans, who had the same sentiment about their women, their sanctity enforced endogamy. "It is probably to this positive character of the sanctity of the Brahman rather than to the negative character of their unwarlike nature that we must look for the clue to the development of endogamy in place of the hypergamy of the Rajputs."

IN the *Irish Naturalist* for September the Rev. W. F. Johnson continues his valuable observations on the Irish Ichneumonidæ and Braconidæ, and records more than one hundred species belonging to these obscure and little known groups of Hymenoptera, mainly from Poyntzpass. Three species are added to the British and Irish list, *Microcryptus femoralis, Glypta schneideri,* and *Mesoleius fraternus.*

ANNALS of the South African Museum (vol. 18, part 3) consists of an important illustrated monograph by Dr. F. Ris on "The Dragon-flies of South Africa." It occupies upwards of 200 pages, and is prefaced by a general account of those structural features which are useful in classification. Both sub-orders of these insects are well represented, and one genus and rather more than a dozen species are described as new. The work should prove valuable to resident entomologists in South Africa as an aid to the identification of the various species, and at the same time enable them to extend our very meagre knowledge of the biology of the dragon-flies of the countries concerned.

OWING to the damage wrought by vast numbers of ducks on the rice-fields of California an aeroplane patrol was established, charged with the task of flying over the fields to frighten away the birds. This method was inaugurated in 1919, and was so successful that now five aeroplanes "are kept busy, making both night and day flights to frighten off the wild ducks." But while the farmers are highly pleased, the American Game Protection Association is greatly perturbed, and this because of the number of birds killed by striking the propellers and guy-ropes. Thus, according to the July issue of *California Fish and Game*, the association has demanded that permits for the use of aeroplanes for this purpose should be revoked.

IN the August issue of the *Entomologist's Monthly Magazine* Mr. E. E. Green describes two new species of Coccidæ from Britain, viz. *Pseudococcus paludinus,* nov., and *Ripersia scirpi,* nov. The former occurred on the foliage of various plants in Wicken Fen, and the latter was met with at Camberley on the stems of *Scirpus caespitosus.* Mr. L. A. Box records *Gronotoma nigricornis,* Keef., a Cynipoid insect new to the fauna of Britain. The insect was bred from the pupæ of an Agromyzid fly found at Blakeney Point, Norfolk. In the September issue of the same journal Mr. B. P. Uvarov describes a new genus and species of wingless, long-horned grasshoppers from the collection in the British Museum. The species, which is named *Chapardina importata,* was obtained from a greenhouse at Richmond, and there is no doubt that it was imported from some exotic country. The land of its origin is a matter for speculation, and it may possibly have come originally from some part of the Oriental region.

IN *La Nature* (No. 2475) M. Léon Bertin reviews recent work on the so-called habit of feigning death which has been attributed to many animals belonging to varied groups, especially to mammals and arthropods. The phenomenon has been variously ascribed to conscious action or intelligence, instinct, or an extreme state of fear, and M. Bertin protests against these vague anthropomorphic explanations unsupported by systematic study and experimental proof. He cites the work of M. Rabaud, who showed that by the stimulation of certain areas of the body of arthropods, particularly the sternum and the lateral parts of the thorax, a state of catalepsy or insensibility could be induced, lasting for varied times according to the strength of the stimulus, the particular animal operated on, and even the temperature. Similarly,

he demonstrated the existence of other areas, the tarsi of the legs and the tip of the abdomen, the excitation of which restored the animal to the normal. M. Rabaud believes that most of the instances of feigning death cited among the arthropods can be explained on the above grounds as pure reflex phenomena in which the organs of perception (visual, olfactory, and auditory) play at most an insignificant part. He even suggests that similar reflex areas can be demonstrated in the vertebrates, and that the feigning of death in that group is also largely a reflex phenomenon. He combats strongly the view that it is a conscious action, or instinctive, or the result of fear, and proceeds to demonstrate that the view that it is a protective attitude is untenable. The precise physiological explanation is still obscure, but M. Bertin rightly insists on the importance of M. Rabaud's observations.

A REPORT prepared for the National Research Council by Messrs. E. B. Mathews and H. P. Little on the position of geology and geography in the United States is published in the Bulletin of the Geological Society of America for April, 1921. It appears from this report that out of 571 colleges and universities, 466, or 81 per cent., offer no instruction in geography. Of the remaining 105 colleges only 31 offer courses of more than two years' duration, and no more than six of these train students in advanced work. Poor as this equipment in geographical teaching is, it is fairly evenly distributed throughout the States with the exception of those in the south. The demand for trained geographers far exceeds the supply. In geology opportunities for training are more satisfactory, although out of the 571 institutions 144 offer no instruction in geology and 268 none worthy of the name. As many as 97 colleges, however, provide courses of four or more years' duration. As in geography, the southern States provide few advanced courses.

THE Geological Survey of Scotland has issued a new edition (1921, 2*s.* 6*d.*) of the memoir describing the Arthur's Seat volcano. Few alterations have been made in Dr. B. N. Peach's text, but Dr. Flett has now described the igneous rocks in accordance with the current classification of the Carboniferous lavas of Scotland. Prof. Judd's view is maintained, namely, that the eruptions form a continuous series, and that the apparent break under the Lion's Haunch is due to the accumulation of the later lavas and agglomerates in a vent from which the earlier bedded lavas had been erupted. A coloured geological map on the scale of six inches to one mile is now inserted in the memoir. The "Summary of Progress of the Geological Survey of Great Britain for 1920" (3*s.* 6*d.*) covers a wide range, from Brockenhurst to Banff. Numerous observations of interest are recorded from western Mull and the adjacent islets. A deposit of Cainozoic desert-sand has been found overlying the chalk at Gribun. The common origin of the two layers of basalt that form respectively the walls and the roof of Fingal's Cave must have been recognised long ago, since Scrope dealt with the matter in the Vivarais in 1825 ("Volcanos," p. 141). We now, however, have an authoritative statement on this point, while a triple zoning is described in other flows, where a slaggy top remains above the irregularly columnar portion.

AN important paper by Prof. H. E. Armstrong and Mr. C. A. Klein on "Paints, Painting, and Painters" is published in the Journal of the Royal Society of Arts of August 26 (vol. 69, No. 3588). As is well known, painters are liable to contract lead poisoning, and at the International Labour Congress to be held in Geneva this month the question of the prohibition of the use of white lead in paint is to be discussed. Prof. Armstrong and Mr. Klein consider that the risk to the painter of lead poisoning has been much exaggerated, and support this conclusion with much experimental work. Some of the ills from which painters suffer are to be attributed, not to the lead, but to the turpentine or other volatile "thinner" with which the paint is made. They point out that white-lead paints have special properties not possessed by substitutes, and they maintain that by the use of a few simple expedients the risks incurred by the painter from the use of lead paints may be practically eliminated. The paper is one that should be studied by all interested in industrial hygiene.

ACCORDING to the report of the work of the Physical Department of the Ministry of Public Works, Egypt, for the year ending March, 1920, the department has returned to normal working conditions from the disturbed state which existed during the war. The hydrographical section is responsible for the Nile gauges and for the rainfall records, and, in addition, tests measuring tapes, thermometers, and barometers. The meteorological section issues the weather reports and forecasts, and runs the Helwan Observatory. A weights and measures section, in maintaining just standards, takes action against three or four thousand persons per annum, and secures convictions in 98 per cent. of the cases. About four thousand scientific instruments were repaired in the workshops during the year, while the research section carried out work on the sulphuric acid hygrometer, and devised and tested a "turbulance gauge" for use in measuring river discharge.

THE "Prizma" process of colour cinematography, invented by Mr. W. V. D. Kelley, which is now being introduced as a practical method, is described in the current number of *Conquest* by Mr. E. R. Mason-Thompson, M.A. It is analogous to "Kinemacolor," but each pair of red-orange and blue-green records is taken simultaneously, the light passing through the lens to the film being divided by optical means so as to give two pictures at each exposure. In printing the positive, the negative moves twice as far as the positive film, and thus all the records of the same colour are printed as consecutive pictures. The positive film is then similarly exposed on its other side (both sides are coated with sensitive emulsion) to the records of the other colour in such manner that each pair of pictures registers. Each side of the film is then separately mordanted and treated with a dye of appropriate colour. The two coloured images being superposed, the positive film is half the length

required by the "Kinemacolor" process, it does not need to be passed through the exhibiting lantern at double the usual speed, and it is claimed that the difficulty of colour fringes in the case of quickly moving objects is eliminated.

An account of the Temple submarine stud driver appears in *Engineering* for September 30. The function of this appliance is to fix studs into ships' plates or other steelwork under water, so that patching plates or attachments for lifting may be bolted on. The studs used at a demonstration at Caxton Hall were of tool steel, tempered to a dark blue colour. One end of the stud is bluntly pointed and the other end has a screw thread cut on it. The studs are shot from the muzzle of a gun held in contact with the plate, and pierce the plate so that about an equal length of the stud is left projecting on both sides. The operation of driving the stud is instantaneous, and the noise is scarcely more than that of an airgun. The explosive charge may consist of any ordinary propellent explosive, and in quantity is about the same as in a standard 0·303 rifle cartridge. It is stated that studs can be driven into solid steel by the Temple gun, and that two $\frac{5}{8}$ in. plates can be pinned together by studs shot through them; also a pin of only $\frac{1}{8}$ in. diameter can be driven through a $1\frac{1}{4}$ in. plate. This appliance, which has been invented by Mr. Robert Temple, is certainly a very remarkable one. The process is in the hands of the Temple Cox Research Company, Dacre House, Dean Farrar Street, Westminster.

Sir Thomas Heath considers that of all the manifestations of the Greek genius none is more impressive, and even awe-inspiring, than that which is revealed by the history of Greek mathematics. The Oxford University Press is publishing immediately in two volumes "A History of Greek Mathematics," by Sir Thomas Heath.

Our Astronomical Column.

The Lunar Eclipse of Sunday, October 16.—This eclipse, which will be nearly total, begins at 9h. 14m. (position angle 45°), reaches its greatest phase (0·938 of the diameter, the south limb being uneclipsed) at 10h. 54m., and ends at 12h. 34m. (position angle 283°). As there is not another large lunar eclipse visible at a convenient altitude in the British Isles until September, 1932, this occasion should be utilised. The chief work during lunar eclipses is the observation of occultations, both phases being visible under similar conditions. Such observations facilitate the determination of the moon's diameter, and serve to test the suggestion that the lunar atmosphere may have more refractive power by day than by night. Six stars in the Bonn Durchmusterung will be occulted during eclipse. The details are given in the following list (computed for Greenwich):—

B.D. number	Mag.	Disappearance	Angle	Reappearance	Angle
°		h. m.	°	h. m.	
7·218	9·2	10 3	24	10 59	292
7·222	9·3	10 19	56	11 35	258
7·224	9·0	10 20	100	11 25	214
7·225	9·5	10 28	70	11 46	243
7·228	9·3	10 57	90	12 10	225
7·227	9·1	11 6	41	12 17	273

The angles are measured from the north point towards the east.

The occultation of 263 B Piscium, mag. 6·4, may also be mentioned, though it does not occur at the eclipsed limb; the times and angles are 8h. 55m., 90°, and 10h. 3m., 224°.

It is also of interest to study the colour and amount of illumination of the region in shadow; probably the variations from one eclipse to another arise from differences in the transparency of the earth's atmosphere. It would be well to examine some of the regions, such as Aristillus, in which Prof. W. H. Pickering has observed changes during the lunation, as it is possible that their appearance might be affected by the passage of the shadow.

Morning Stars.—Before sunrise on clear mornings, during the last half of October, there will be an unusual and striking display of four brilliant planets. Venus, Mars, Jupiter, and Saturn will all be visible, and will continue to be so during the remaining months of the present year.

Their variations of position will induce a number of interesting conjunctions and configurations, both amongst themselves and with the waning crescent of the moon as she passes them in her monthly round.

On October 16 Venus will rise at 3.43 a.m., Mars at 3.0 a.m., Jupiter at 4.41 a.m., and Saturn at 4.19 a.m. On this date, an hour before sunrise, the four planets named will form an almost perpendicular line over the east by south horizon.

The following conjunctions will occur:—

	h. m.			° ′	
Oct. 22	7 55 a.m.	Venus and Saturn	Venus	0 35	South
,, 25	4 12 p.m.	Venus and Jupiter	Venus	0 31	North
,, 28	1 18 a.m.	Mars and Moon	Mars	3 38	,,
,, 28	3 24 p.m.	Saturn and Moon	Saturn	3 41	,,
,, 28	10 0 p.m.	Jupiter and Moon	Jupiter	2 14	,,
,, 29	3 56 a.m.	Venus and Moon	Venus	2 25	,,
,, 30	11 58 p.m.	Mercury and Moon	Mercury	2 36	South

These occurrences will not be all visible, as they take place at unsuitable times, but the objects mentioned may be observed in proximity on the mornings before and after the events named.

In November, during the last fortnight of the month, the planet Mercury will also be favourably visible and add another interesting object to the unusual assemblage of brilliant planets in the morning sky.

Large Fireball.—Mr. W. F. Denning writes:—"On October 6, 9h. 25m. G.M.T., a fireball of unusual brilliancy was observed by Mr. J. P. M. Prentice at Stowmarket. It was of a beautiful orange colour, with a thick streak, and burst in the middle of its flight, leaving a blue-green cloud of gaseous material which was visible for eight seconds. The fireball was also seen by the writer at Bristol, and he rated it as much more brilliant than Venus, but it was unfavourably seen right through a cloud, which it rather brightly illuminated. The nucleus could be distinctly traced as it pursued its path, and the position could be accurately recorded from a few bright stars which were not obscured at the moment. The radiant point of the object was near β-Aurigæ at 87°+40°, and the height of the object from 86 to 48 miles from over the mouth of the Thames to Littlehampton in Sussex."

The Australian National Research Council.

A CERTAIN measure of co-ordination and co-operation in science was achieved during the war by Great Britain, France, America, and Japan, with results which were far-reaching in importance. Men of science in Australia felt that something of the sort would also be productive of good results in that continent, which until recently was represented in the world of science solely by independent State Royal Societies. The climax was reached in 1919, when the International Research Association meeting in Paris invited the co-operation of Australian men of science. No representative scientific body, with the exception of the Australian Association for the Advancement of Science, which had not met since 1913, was in existence at that time, so the matter was referred to the Melbourne meeting of the association, held on January 5–11 last (NATURE, May 26, p. 408). There it was decided that an Australian National Research Council should be formed and organised on lines similar to those adopted by countries already working under the International Research Council. A scheme of organisation was drawn up and approved by the Australasian Association, which provided for a council of a hundred members representative of pure and applied science.

Australia has now, therefore, three organisations of a general scientific nature apart from Government Departments, State societies, and museums. First there is the Australasian Association for the Advancement of Science, which meets normally every second year. Even if more frequent meetings were possible, lack of funds would probably hinder the effective direction of investigations by this body. Then there is the newly constituted National Research Council, in regard to which Sir Baldwin Spencer suggested in his presidential address to the Australasian Association at Melbourne that it might, with the view of economising time, energy, and money, be constituted as the standing committee of the Australasian Association, with independent powers of initiating research and dealing with such funds as were placed at its disposal. The third scientific organisation in existence is the Commonwealth Institute of Science and Industry, founded by Act of Parliament in 1920. The constitution of this body is not considered satisfactory by men of science, but it demonstrates official recognition of the importance of scientific investigation, and at present it is the only one of the three organisations which can command the funds necessary for carrying out investigations. Sir Baldwin Spencer is of opinion that the constitution of the National Research Council of the United States might have been copied with advantage when this body came into being.

However, now that the Australian National Research Council is an accomplished fact, it is hoped that it will serve as a representative Australian unit in international scientific organisation, and, in addition, have an important influence in encouraging scientific research in Australia.

The following is a list of members of the council as it is at present constituted :—

Agriculture: Mr. F. B. Guthrie, Prof. A. J. Perkins, Mr. A. E. V. Richardson, and Prof. R. D. Watt.

Anthropology: Prof. R. J. A. Berry, Mr. C. Hedley, Rev. John Matthew, Mr. S. A. Smith, Sir Baldwin Spencer, and Prof. F. Wood-Jones.

Astronomy: Dr. J. M. Baldwin, Prof. W. E. Cooke, Mr. E. F. Dodwell, and the Rev. E. F. Pigot.

Botany: Mr. R. T. Baker, Mr. R. H. Cambage, Prof. A. J. Ewart, Prof. A. A. Lawson, Mr. A. H. S. Lucas, Mr. J. H. Maiden, and Prof. T. G. B. Osborn.

Chemistry: Prof. C. E. Fawsitt, Mr. J. B. Henderson, Mr. A. E. Leighton, Prof. Orme Masson, Prof. J. Read, Prof. E. H. Rennie, Assoc.-Prof. A. C. D. Rivett, Mr. H. G. Smith, Prof. B. D. Steele, and Prof. N. T. M. Wilsmore.

Economics and Statistics: Mr. G. H. Knibbs and Mr. G. Lightfoot.

Engineering: Mr. J. J. C. Bradfield, Prof. R. W. Chapman, Mr. A. J. Gibson, and Mr. A. G. Michell.

Geography: Capt. John King Davis, Mr. Loftus Hills, Prof. W. Howchin, and Sir Douglas Mawson.

Geology: Mr. E. C. Andrews, Sir Edgeworth David, Mr. B. Dunstan, Mr. A. Gibb Maitland, Prof. H. C. Richards, Prof. E. W. Skeats, Dr. F. L. Stillwell, and Mr. L. Keith Ward.

Mathematics: Prof. H. S. Carslaw, Mr. A. McAulay, Mr. J. H. Michell, Prof. H. J. Priestley, and Mr. E. M. Wellish.

Mental Science and Education: Prof. Francis Anderson and Prof. William Mitchell.

Meteorology: Mr. H. A. Hunt and Prof. T. Griffith Taylor.

Mining and Metallurgy: Mr. G. D. Delprat, Mr. G. C. Klug, Mr. R. Sticht, and Mr. W. E. Wainwright.

Pathology: Sir Harry B. Allen, Dr. A. W. Campbell, Prof. J. B. Cleland, Dr. S. W. Patterson, Dr. W. J. Penfold, and Prof. D. A. Welsh.

Physics: Prof. K. Grant, Prof. T. H. Laby, Dr. E. F. J. Love, Prof. T. R. Lyle, Prof. T. Parnell, Prof. J. A. Pollock, and Assoc.-Prof. Vonwiller.

Physiology: Prof. H. G. Chapman, Dr. E. E. Embley, Prof. W. A. Osborne, and Prof. Brailsford Robertson.

Veterinary Science: Dr. Sydney Dodd, Dr. J. A. Gilruth, Prof. J. D. Stewart, and Prof. R. A. Woodruff.

Zoology: Dr. W. E. Agar, Mr. J. J. Fletcher, Mr. W. W. Froggatt, Prof. W. A. Haswell, Prof. T. Harvey Johnston, Assoc.-Prof. Georgina Sweet, and Mr. G. A. Waterhouse.

The first meeting of the Australian National Research Council was held in Melbourne on August 23–25 last, at which the nature of the work it would undertake was discussed.

Sir Edgeworth David, at a reception before the business sessions, said that he hoped the first full meeting of the National Research Council would be an epoch-making day in the annals of Australian science. Never in the whole history of Australia was there such a need for co-ordination in scientific effort. It would help to defend the country against foreign aggression. The public had no idea what we owed to science for our final victory in the great war.

Later, an executive committee, constituted as follows, was elected: *President:* Sir Edgeworth David. *Vice-Presidents:* Sir Baldwin Spencer, Prof. Orme Masson, Mr. G. H. Knibbs, and Mr. J. H. Maiden. *Members:* Sir Douglas Mawson, Profs. H. J. Priestley, E. W. Skeats, B. D. Steele, N. T. M. Wilsmore, R. W. Chapman, J. A. Pollock, K. Grant, and T. R. Lyle, Messrs. L. Hills, and W. E. Wainwright. *Secretary:* Mr. Cambage. There was some discussion as to the qualifications of associate members, and it was decided to admit as associate members only those who have carried out meritorious original scientific work.

One of the subjects of discussion of the second day's meeting was a motion on the order paper in

the name of Prof. T. H. Laby, that the Australian National Research Council should adopt such a constitution as would enable it to perform the following functions: (*a*) The discussion and publication of the results of scientific investigation by the publication of scientific papers and by co-operating with the State scientific societies in such work. (*b*) The promotion of scientific research generally, and the investigation of specific problems, bringing the latter under the notice of the Commonwealth and State Governments when that course is desirable. (*c*) The promotion of the application of scientific methods in questions of government and administration when such methods are peculiarly and specially applicable. (*d*) The promotion of the interest and status of scientific workers in Australia. The first of these clauses was negatived by a large majority, but the publication by the Council of abstracts of scientific papers by Australians was agreed to. Clauses (*b*) and (*c*) were carried, but clause (*d*) was rejected. In the discussion on the last clause Prof. Agar said that the Council should confine its attention to furthering the interests of science rather than the interests of men of science. The Council also rejected a proposal made in connection with the foregoing motions that it should form from those of its members who represent mathematics, physics, astronomy, and engineering, a section for the encouragement, discussion, and publication of research in the mathematical and physical sciences.

A letter from Sir Arthur Schuster, inviting the Council to submit business for consideration at the Brussels meeting of the International Research Council was considered. In this connection it was agreed to represent to the Commonwealth Government the need for funds to enable Australia to join certain of the International Unions. Mr. E. C. Andrews was appointed a delegate to the Pan-Pacific Scientific Congress to be held in 1923.

Among other business transacted, Sir Edgeworth David directed attention to the desirability of forming a Commonwealth Geological Survey, in addition to the State surveys, and further action is to be taken. A committee was also appointed to report on the possibility of making a gravity survey of Australia.

A special committee then reported on the proposed establishment of a solar radiation station at Sydney; the necessary funds had been raised successfully by public subscription, and it was considered that the project was a matter of considerable scientific importance.

The National Council formally took over from the Australasian Association for the Advancement of Science work of an international character relating to geophysics and physical and chemical constants.

The Australian National Research Council, so far as its constitution and objects are determined, is to be exclusive in character, and it will be concerned with the organisation of scientific work in Australia, and with co-operation in international research, but it will not discuss or publish scientific papers.

Scottish Fisheries.

By PROF. W. C. MCINTOSH, F.R.S.

THE Thirty-ninth Annual Report of the Fishery Board for Scotland, 1920 (H.M. Stationery Office, 3*s*.), as usual, contains much important information connected with the Scottish fisheries. In the introduction the Board refers to the present depressed condition of the industry, which is due, not to dearth of fishes of all kinds, but to industrial and transport troubles and the general unrest, as well as the partial dislocation of foreign trade in cured fishes. It bewails the increasing incursions of foreign trawlers in the Moray Firth, unmindful that the closure of the area beyond the three-mile limit was, as Lord Bryce and others long ago pointed out, the *fons et origo* of the trouble. The figures of the captures for 1920 show that with 1366 fewer boats than in the record year 1912 the quantity landed was 2,261,167 cwt. less. The supposition concerning the "accumulation" of fishes during war-time is conjectural.

The present remarks, however, mainly deal with the Board's scientific fisheries work, which, so far as its experienced staff is concerned, maintains its high standard. The Board apparently believes in the International Council for the Exploration of the Sea, yet it does not explain how this international *camaraderie* has failed to put an end to the raids of foreign trawlers in the Moray Firth. Indeed, it may well be doubted if, after twenty-one years' experience of the International Council, any practical result of importance to the British fisheries has resulted from the large expenditure, or evolved any solid basis for the revival of the scheme. The details of the Board's expenditure on this head should at once be published. Further, it is remarkable that the chairmanship of this Council has hitherto been only in British or German hands (often unscientific). The most experienced fisheries research workers firmly believe that, with all deference to the international exchange of views, real progress lies in the work of each country's scientific staff in its own ships and marine laboratories. That the Board is open to criticism is apparent from the fact that whilst other nations, notably the Danes, have worked up the life-histories of the food and other fishes collected in their ships in a praiseworthy manner, the large collection of eggs, larval, post-larval, and young fishes procured by the Board's steamer, with perhaps a few trifling exceptions, is unknown. Instead of leading the way in such work, the Board appears to pin its faith in this department to endless, but expensive, statistics of captures here and there. It clings to the notion that by a size-limit or by the closure of areas of the North Sea (which it formerly abjured) plaice will be benefited—forgetful of the persistence of this fish, notwithstanding the pessimism of nigh a thousand years. The recent work of Dr. Petersen, of Copenhagen, on intensive plaice-fishing will afford the Board some information on this head. The Board's intention to ascertain the present condition of the fishing-grounds (an advice given many years ago) is to be commended, as also is the development of oyster fisheries, though the decline of the oyster fisheries of the Forth is as yet unremedied. A profitable field for the energies of the Board would also be the encouragement of the canning of the sprats from the Forth, Tay, and other places.

The Board finally alludes to the reorganisation of its scientific staff, and it is to be hoped that, warned by the experiences in the Fishery Departments of England and Canada, untried, or even non-scientific, men will not be placed over the heads of trained scientific workers of perhaps a quarter of a century's experience. Whilst these public Departments have in many respects a free hand, science and the public also have rights, interference with which will soon lower the status of those who enter on such work.

University and Educational Intelligence.

CAMBRIDGE.—The vote on the admission of women to the University will be taken on Thursday, October 20. The point at issue this time is as follows:—Grace I., which is accepted by the women's colleges as a solution and is supported by them, admits women to membership of the University with full privileges except for a vote on the Senate, the governing body of the University. On the other hand, it grants to the women the right to elect two assessors to sit on the Council of the Senate without votes—a measure that may be of more immediate assistance to them than the vote which the University refused to them last December. Women become eligible for University offices, studentships, and prizes. On the other hand, their numbers are limited. An opportunity for independent development of men's and women's education is offered which may prove very valuable in the future, and their discipline is also differentiated from the men's. One very important condition attached to Grace I. is that men's and women's colleges shall be, and shall remain, distinct.

The alternative, Grace II., offers only titular degrees—a solution which might have been satisfactory in 1897, but is not acceptable at the present day. The carrying of Grace I., which embodies the conclusions of a body formed from all parties except the extremists on either side, offers the only hope of an agreed solution of this long-standing controversy from within the University proper.

Col. Sir Gerald Lennox-Conyngham, Mr. D. C. Henry, and Mr. C. D. Ellis have been elected fellows of Trinity College. The first-named has also been elected prælector of geodesy at Trinity College, and to him will be entrusted the task of building up a school of geodesy in Cambridge. Once again in starting a new scientific school Trinity College has wisely and generously made the University its debtor. Previous instances of a similar kind are the late Sir Michael Foster and Prof. F. G. Hopkins.

LEEDS.—Sir Edward Allen Brotherton, Bart., has given 20,000*l.* to the University for the development of bacteriological study and research, more particularly in the interests of public health. This is the largest individual gift yet received by the University of Leeds.

LONDON.—Some interesting public lectures are announced to be delivered at King's College, London, during the coming term. The department of history and geography has arranged for a course of lectures on the British Empire, which includes the following:—"Geological and Geographical Physical Basis," by Prof. W. T. Gordon, on October 26; "Fauna," by Prof. A. Dendy, on November 2; "Flora," by Prof. R. R. Gates, on November 9; and "Anthropology," by Prof. G. Elliot Smith, on November 16. In each case the lecture-hour is at 5.15 p.m.

DR. FRANCES M. G. MICKLETHWAIT has resigned the post of principal of the Horticultural College, Swanley, to which she was appointed in January last year.

AN election to Beit memorial fellowships for medical research will take place on or before January 1 next. Applications must be received before October 31. Forms of application and all information may be obtained by letter only addressed to the Honorary Secretary, Beit Memorial Fellowships for Medical Research, 35 Clarges Street, Piccadilly, W.1.

A TEACHERS Conference under the auspices of the League of Nations Union will be held on Saturday, October 22, in the Hall of Reading University College. The opening address on education and international co-operation will be given by Prof. Gilbert Murray at 11 a.m. Communications should be sent to Mr. J. Eppstein, secretary of the conference, 40, Redlands Road, Reading.

AT the next dinner of the Groupe Inter-Universitaire Franco-Britannique, to be held on Tuesday, November 1, at the Connaught Rooms, Great Queen Street, Kingsway, W.C.2, the chair will be taken by M. Raymond Poincaré, past-President of the French Republic and former Rector of the University of Glasgow, who will speak on "The Utility of Inter-Allied Intellectual Relationship." Applications for tickets should be made as early as possible, and in any case not later than Thursday, October 20, to Mr. H. Sloog (hon. secretary), 51 Anson Road, N.W.2. The association was formed in June, 1918, for the purpose of promoting friendly intercourse between British and French university men and persons prominent in the worlds of art, literature, science, commerce, and industry in either country. The membership has since been extended to university men of all Allied and associated nations.

THE *Meteorological Magazine* for September gives a provisional programme of lectures and classes for the 1921–22 session in the School of Meteorology, Imperial College of Science and Technology. Sir Napier Shaw gives a course of four lectures on "Fog" on Mondays of the first term at 3.30 p.m., which commenced on October 10, followed by a course of three lectures on "The Winds above Clouds" on Mondays of the first term at 3.30 p.m., beginning November 7. He will also deliver a course of ten lectures on "The Structure of the Atmosphere and the Meteorology of the Globe" on Fridays of the second term at 3 p.m., beginning January 20, 1922. Dr. C. Chree gives a course of four lectures on "Terrestrial Magnetism" on Mondays of the first term at 3.30 p.m., beginning November 28; while Capt. D. Brunt gives a general course on "Physical and Dynamical Meteorology" on Thursdays of the first and second terms at 2.30 p.m., beginning October 13, 1921. Particulars of these courses may be obtained from the Meteorological Office, South Kensington.

THE Royal Technical College, Glasgow, has recently issued a calendar for the session 1921–22 giving details of the various courses of instruction available at the college. Full-time courses have been arranged which lead to the diploma and associateship of the college in civil, mechanical, electrical, and mining engineering, chemistry, and metallurgy. For the diploma a three-year course must be taken, while for the associateship a fourth year's study is necessary, and in the case of chemistry or metallurgy a thesis on some subject of experimental research must be submitted. The diploma courses are in most cases suitable for students taking the B.Sc. examinations of Glasgow University. Evening courses in the various subjects will also be available for students who have completed a two years' continuation course and to others who can show evidence of equivalent status. Courses in engineering for apprentices have been arranged as part of a scheme of co-operation with some seventy engineering firms in and round Glasgow, whereby selected apprentices attend winter courses at the college and the intervening summers in works. Many of these firms recognise the time spent at the college as part of the period of apprenticeship.

Calendar of Scientific Pioneers.

October 13, 1666. William Hopkins died.—The Cambridge tutor of Tait, Maxwell, Kelvin, and Stokes, Hopkins, in 1850, received the Wollaston medal for his researches on the application of mathematics to physics and geology, and the following year was elected president of the Geological Society.

October 14, 1831. Jean Louis Pons died.—While connected with the observatories at Marseilles, Lucca, and Florence, Pons discovered thirty-seven comets.

October 15, 1907. Maurice Loewy died.—Born in Vienna, of Jewish parentage, and trained under Littrow, Loewy was invited to Paris by Leverrier in 1860. In 1896 he succeeded Tisserand as director of the Paris Observatory. He completed the great Paris catalogue of stars, and energetically supported the International Photographic Chart. The first equatorial coudé was erected by him in 1882.

October 16, 1793. John Hunter died.—A great comparative anatomist and the founder of the famous Hunterian collection, Hunter for many years was one of the surgeons of St. George's Hospital, London. Interred in St. Martin's-in-the-Fields, his remains, through the efforts of Frank Buckland, were transferred in 1859 to Westminster Abbey.

October 16, 1876. Wolfgang Sartorius, Baron von Waltershausen, died.—After carrying out magnetic work in various parts of Europe, von Waltershausen made a study of Mount Etna, and in 1858–61 published his "Atlas des Ätna." For about thirty years he held the chair of mineralogy at Göttingen.

October 17, 1757. René Antoine Ferchault de Réaumur died.—For nearly fifty years a prominent member of the Paris Academy of Sciences, Réaumur has been called the Pliny of the eighteenth century. His investigations on the cementation of steel were of great practical importance. As a naturalist he is best known for his "Mémoires pour servir à l'Histoire des Insectes," 1737–48.

October 17, 1887. Gustav Robert Kirchhoff died.—While professor of physics at Heidelberg, Kirchhoff, in 1859, by a comparison of the solar spectrum with the spectra of various elements, created spectrum analysis. Assisted by Bunsen in 1861, he discovered cæsium and rubidium; his map of the solar spectrum was published by the Berlin Academy shortly afterwards.

October 18, 1871. Charles Babbage died.—Sometime Lucasian professor of mathematics at Cambridge, Babbage was a founder of the British Association, and of the Astronomical and Statistical Societies. With Herschel, Peacock, and Woodhouse he was one of the reformers of mathematical studies at Cambridge. For more than thirty years he spent much time and money on elaborate calculating machines, which, never completed, are now in the Science Museum at South Kensington.

October 19, 1875. Sir Charles Wheatstone died.—A pioneer worker on the transmission of electricity, Wheatstone, in 1834, became professor of experimental physics at King's College, London, and afterwards with Fothergill Cooke played an important part in the development of the electric telegraph. He also did valuable work in acoustics.

October 19, 1906. Friedrich Konrad Beilstein died.—German by birth but Russian by nationality, Beilstein was widely known for his researches on the aromatic series and on petroleum, and for his "Handbuch der Organischen Chemie," a work of reference held in high esteem. E. C. S.

Societies and Academies.

PARIS.

Academy of Sciences, September 26.—M. Léon Guignard in the chair.—A. **de Gramont** and G. A. **Hemsalech**: The *rôle* of electrical actions in the emission and appearance of certain types of lines of the magnesium spectrum. A detailed account of the variations in the lines produced by changing the conditions under which the arc or spark is maintained. The arc was struck between magnesium electrodes under water, glycerol, and petroleum, and the sparks were passed in atmospheres of hydrogen, oxygen, coal gas, and nitrogen. During the first phase of the arc struck in a liquid drop, modifications of the lines are caused by the intense electric fields.—L. **Casteels**: A type of doubly continuous quadratic generation of a plane cubic given by nine simple points.—T. **Varapoulos**: Some properties of increasing functions.—J. **Chazy**: The Poisson stability in the problem of three bodies.—J. **Guillaume**: Observations of the sun made at the Lyons Observatory during the first quarter of 1921. Observations were taken on seventy-seven days in the quarter, and the principal facts are resumed in three tables, showing the number of spots, the distribution of the spots in latitude, and the distribution of the faculæ in latitude.—K. **Ogura**: The static field of gravitation.—E. **Hulthen**: The combinations in band spectra.—M. and L. **de Broglie**: The corpuscular spectra of the elements. A statement of experimental results on the corpuscular excitation of the heavy metals (uranium, thorium, lead), by the X-rays, and bearing on the L, M, and N levels of electrons.—E. **Passemard**: The alluvial terraces of Sebou above Fez. There is clear evidence of the existence in the Sebou valley of three terraces, 30 metres, 16 metres, and 7 metres. The higher terraces have certainly existed, but are now represented by *débris*.—A. **Lumière** and H. **Couturier**: Sodium oleate in the phenomena of shock. When a 1 per cent. solution of sodium oleate is injected into the jugular vein of sensitised guinea-pigs, it is known that these animals can stand, without inconvenience, an injection of the antigen which is mortal to a sensitised animal not treated with the oleate solution, and this protective action has been attributed to the property possessed by sodium oleate of diminishing the surface tension of liquids to which it is added. The authors do not accept this explanation, and show that solutions of sodium oleate alone can produce the symptoms of anaphylactic shock. These symptoms can be suppressed by solutions of sodium hyposulphite.

BRUSSELS.

Royal Academy of Belgium, June 4.—M. G. Cesaro in the chair.—A. **Demoulin**: The minimum surface of Enneper.—Cl. **Servais**: A group of three biological Caylean tetrahedra.—M. **Stuyvaert**: The theorems of Fermat and Euler.—H. **Kufferath**: The stereogrammatic interpretation of the sporulation curve of yeasts, described by Hansen. Its application to physiological and biological phenomena. The author has repeated and extended the observations of Hansen on the sporulation of yeasts. The medium used differed from that of Hansen, and the rate of growth was much slower, but the results fully confirm those of Hansen, as regards the average time of the first proof of the existence of spores at varying temperatures.—P. T. **de Chardin** and C. **Fraipont**: The presence in the lower tertiary of Belgium of a member of the Hyopsodus group.—J. **Errera**: Contribution to the knowledge of the cuprous compounds. Experimental evidence is given of the existence of cuprous

nitrate. The products obtained by the electrolysis of alkaline bicarbonates with a copper anode, and by the electrolysis of solutions of carbon dioxide with copper anode under pressure have been examined.—M. **Philippson**: The laws of the electrical resistance of living tissues. Cellular membranes behave as capacities towards alternating currents. Formulæ are given for the electric conductivity of living tissues, and one of the constants in these formulæ characterises the physico-chemical state of the protoplasm.

SYDNEY.

Linnean Society of New South Wales, August 31.—Mr. G. A. Waterhouse, president, in the chair.—H. J. **Carter**: Australian Coleoptera: notes and new species. The paper includes descriptions of Queensland material lately acquired by the Queensland Museum, of specimens from Northern Territory, and of two new species from the Barrington or Mount Royal Range, N.S.W. Thirty-six species belonging to twenty-six genera in the families Lucanidæ, Buprestidæ, Tenebrionidæ, and Cistelidæ are described as new.—G. H. **Hardy**: A preliminary revision of some genera belonging to the Diptera Brachycera of Australia. In this revision certain characters considered to be of primary importance are used in defining some of the genera. In the Asilidæ the antennal characters are used for distinguishing the genera belonging to the sub-family Dasypogoninæ. Two robber-flies belonging to the genus Blepharotes are described as new. The genus Clesthentia, White, is transferred from the Leptidæ to the Therevidæ, and taxonomic improvements for the latter family are suggested. Attention is directed to the need for revision of the type specimens of the Australian species of Apiocera, the only genus of the Apioceridæ represented in Australia.—J. M. **Petrie**: The active principle of *Erythrophloeum Laboucherii*. Examination of a small amount of air-dried leaves and a few beans of *Erythrophloeum Laboucherii* proved that cyanogenetic glucosides and saponins were absent, but that a small percentage of a poisonous alkaloid was present. 2·8 kg. of leaves yielded 56 mg. of an amorphous alkaloid, while 290 g. of the beans yielded 87 mg. of the same alkaloid. Both the chemical and physiological properties of this alkaloid prove it to be identical with the erythrophleine of the African plant, *E. guineense*. The general action of the digitalis group was observed in experiments carried out with the alkaloid of *E. Laboucherii* on frogs and dogs.

Books Received.

An Experiment in the Eradication of Plague Infection, carried out in the Poona and Adjacent Districts. By Major J. C. G. Kunhardt and Asst.-Surg. G. D. Chitre. First Report: for the Period 1914–1916. Pp. 409–445+charts. Second Report: for the Period 1916–1918. Pp. 446–489+tables. (From *The Indian Journal of Medical Research*, vol. 8, No. 3.) (Calcutta: Thacker, Spink and Co.)

Memoirs of the Geological Survey: Special Reports on the Mineral Resources of Great Britain. Vol. 22: The Lead and Zinc Ores of the Lake District. By T. Eastwood. Pp. iv+56. (Southampton: Ordnance Survey Office; London: E. Stanford, Ltd.) 2*s*. net.

Department of Scientific and Industrial Research: Fuel Research Board. Technical Paper No. 4: The Carbonisation of Peat in Vertical Gas Retorts. Pp. 16. (London: H.M. Stationery Office.) 6*d*. net.

Junk's Natur-Führer. Süd-Bayern. Von R. H. France. Pp. v+423. (Berlin: W. Junk.) 32 marks.

Fuel and Refractory Materials. By A. H. Sexton. New edition, completely revised and enlarged by Dr. W. B. Davidson. Pp. vii+382. (London: Blackie and Son, Ltd.) 12*s*. 6*d*. net.

Hydro-Electric Engineering. Edited by Dr. A. H. Gibson. Vol. 1: Civil and Mechanical. By H. W. Cook and the Editor. Pp. x+232. (London: Blackie and Son, Ltd.) 25*s*. net.

Strasburger's Text-book of Botany. Re-written by Dr. H. Fitting and others. Fifth English edition, revised with the fourteenth German edition by Prof. W. H. Lang. Pp. xi+799. (London: Macmillan and Co., Ltd.) 31*s*. 6*d*. net.

Industrial Fatigue and Efficiency. By Dr. H. M. Vernon. (Efficiency Books.) Pp. viii+264. (London: G. Routledge and Sons, Ltd.) 12*s*. 6*d*. net.

Library of the Rothamsted Experimental Station, Harpenden. Catalogue of Journals and Periodicals. Pp. 70. (Rothamsted.) 2*s*. 6*d*.

Anales del Museo Nacional de Historia Natural de Buenos Aires. Tomo 29. Pp. v+688+4 plates. (Buenos Aires.)

Thought and Expression in the Sixteenth Century. By Dr. H. O. Taylor. Vol. 1. Pp. xiv+427. Vol. 2. Pp. viii+432. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 2 vols. 50*s*. net.

An Introduction to the Theory of Relativity. By L. Bolton. Pp. xi+177. (London: Methuen and Co., Ltd.) 5*s*. net.

Sculpture sur Bois. Par Hippolyte Gaschet. (Bibliothèque professionnelle.) Pp. 206. (Paris: J. B. Baillière et Fils.) 6 francs net.

Applied Entomology: An Introductory Text-Book of Insects in their Relations to Man. By Prof. H. T. Fernald. Pp. xiv+386. (New York and London: McGraw Hill Book Co., Inc.) 21*s*. net.

The Intestinal Protozoa of Man. By C. Dobell and F. W. O'Connor. Pp. xii+211+8 plates. (London: J. Bale, Sons and Danielsson, Ltd.) 15*s*. net.

Organic Analysis, Qualitative and Quantitative. By E. de Barry Barnett and P. C. L. Thorne. Pp. xi+168. (London: University of London Press, Ltd.) 7*s*. 6*d*.

The Rudiments of Relativity: Lectures delivered under the Auspices of the University College, Johannesburg, Scientific Society. By Prof. J. P. Dalton. Pp. vi+105. (Witwatersrand: Council of Education; London: Wheldon and Wesley, Ltd.) 5*s*. net.

Imperial Institute: Monographs on Mineral Resources, with Special Reference to the British Empire. Silver Ores. By Dr. H. B. Cronshaw. Pp. ix+152. (London: J. Murray.) 6*s*. net.

Imperial Institute: Monographs on Mineral Resources, with Special Reference to the British Empire. Petroleum. Prepared jointly with H.M. Petroleum Dept. with the co-operation of Dr. H. B. Cronshaw. Pp. x+110. (London: J. Murray.) 5*s*. net.

Studies in Christian Philosophy: Being the Boyle Lectures, 1920. By the Rev. Prof. W. R. Matthews. Pp. xiv+231. (London: Macmillan and Co., Ltd.) 12*s*. net.

The Cambridge Pocket Diary, 1921–22. Pp. xv+277. (Cambridge: At the University Press.) 3*s*. net.

Report of the Committee of the Privy Council for Scientific and Industrial Research for the Year 1920–21. (Cmd. 1401.) Pp. 121. (London: H.M. Stationery Office.) 1*s*. net.

Department of Applied Statistics (Computing Section), University of London, University College.

Tracts for Computers, No. 6. Smoothing. By E. C. Rhodes. Pp. 60+3 diagrams. (London: Cambridge University Press.) 3s. 9d. net.

Map Projections. By A. R. Hinks. Second edition, revised and enlarged. Pp. xii+158. (Cambridge: At the University Press.) 12s. 6d. net.

A Memoir of the Rt. Hon. Sir Edward Fry, G.C.B., 1827–1918. By Agnes Fry. Pp. 328. (London: Oxford University Press.) 12s. 6d. net.

A Study of Mathematical Education, including the Teaching of Arithmetic. By B. Branford. New edition, enlarged and revised. Pp. xii+432. (Oxford: Clarendon Press.) 7s. 6d. net.

Monographs on the Theory of Photography, from the Research Laboratory of the Eastman Kodak Co. No. 1: The Silver Bromide Grain of Photographic Emulsions. By A. P. H. Trivelli and S. E. Sheppard. Pp. 143. (New York: D. van Nostrand Co.; Rochester, N.Y.: Eastman Kodak Co.; London: Kodak, Ltd.) 15s.

Diary of Societies.

THURSDAY, OCTOBER 13.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. C. W. Kimmins: Springs of Laughter.

OPTICAL SOCIETY (at Imperial College of Science), at 7.30.—Dr. C. Sheard: Thomas Young Oration.

INSTITUTE OF METALS, LONDON SECTION (at Sir John Cass Technical Institute), at 8.—Dr. O. F. Hudson: Chairman's Address.

SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (In Lecture Room, Hotel Cecil), at 8.—Dr. Marie Stopes: Anecdotes of the Past, Present, and Future of Birth Control (Presidential Address).

ABERNETHIAN SOCIETY (at St. Bartholomew's Hospital), at 8.30.—Dr. C. Addison: Medical Men and Public Life.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—P. Sargent: Presidential Address.

FRIDAY, OCTOBER 14.

ASSOCIATION OF ECONOMIC BIOLOGISTS (In Botanical Lecture Theatre, Imperial College of Science), at 2.30.—Dr. W. Brown and Others: Discussion on the Physiology of the Infection Process.

JUNIOR INSTITUTION OF ENGINEERS (Inc.), at 8.—C. H. Woodfield: Electric Cranes.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—J. H. Parsons: The Fourth Cranial Nerve.—E. Clarke: Milestones in Refraction Work.

SATURDAY, OCTOBER 15.

PHYSIOLOGICAL SOCIETY (at Guy's Hospital), at 4 p.m.—N. W. MacKeith, M. S. Pembrey, W. R. Spurrell. E. C. Warner, and H. J. W. J. Westlake: Changes in Urine and Respiration in Relation to Exercise.—G. P. Crowden, Gwenda Hill, and M. S. Pembrey: Physiological and Anatomical Comparisons of a Pair of Identical Twins.—E. D. Adrian and A. Forbes: The All-or-Nothing Response of Sensory Nerve Fibres.—G. S. Adair, J. Barcroft, and A. V. Bock: The Identity of Hæmoglobin in Human Beings.—M. Nagahashi: Magnetic Gas Analysis.—J. C. Drummond, G. P. Crowden, and Gwenda Hill: Nutrition on High Protein Dietaries.—B. J. Collingwood: The Constitution of Blood after the Intravenous Injection of (*a*) a Solution of Thrombin, prepared by the Gamgee Method; and (*b*) Tissue Extract.—A. V. Hill and W. E. L. Brown: The Effect of CO_2 on the Heat of Combination of Hæmoglobin and Oxygen.—J. Mellanby: Asphyxia by Nitrogen.

TUESDAY, OCTOBER 18

ROYAL HORTICULTURAL SOCIETY, at 3.—N. H. Grubb: Some Aspects of Apple Pruning.

ROYAL COLLEGE OF PHYSICIANS, at 4.—Dr. H. R. Spencer: (Harveian Oration).

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—The Secretary: Report on the Additions made to the Society's Menagerie during the months of June, July, August, and September, 1921.—M. A. C. Hinton: Exhibition of an Embryo African Elephant.—A. Stanley Hirst: On Some New Parasitic Mites.—Prof. J. Playfair McMurrich: Note on the Systematic Position and Distribution of *Sagartia luciae*.

WEDNESDAY, OCTOBER 19.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Dr. L. T. Hogben: Preliminary Account of the Spermatogenesis of Sphenodon.—D. M. Stump: An Application of Polarised Light to Resolution with the Compound Microscope.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Commercial Vehicle and Motor Car and Marine Exhibitions, Olympia).—H. S. Hall and H. G. Burford; E. H. Arnott: Agricultural Tractors.

THURSDAY, OCTOBER 20.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—G. Brewer: The Langley Machine and the Hammondsport Trials.

CHEMICAL SOCIETY, at 8.—R. L. Grant and F. L. Pyman: Nitro- and Amino-derivatives of 4-Phenylglyoxaline.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Commercial Vehicle and Motor Car and Marine Exhibitions, Olympia).—T. Clarkson: Coke as a Fuel for Commercial Vehicles.—W. D. Williamson: Loading Devices for Commercial Vehicles.

FRIDAY, OCTOBER 21.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Dr. W. Rosenhain, S. L. Archbutt, and Dr. D. Hanson: Eleventh Report to the Alloys Research Committee on Some Alloys of Aluminium.

PUBLIC LECTURES.

(A number in brackets indicates the number of a lecture in a course.)

THURSDAY, OCTOBER 13.

KING'S COLLEGE, at 5.30.—H. W. Fitz-Simons: Bridge Construction (1).

UNIVERSITY COLLEGE, at 4.—Dr. T. G. Pinches: Babylonian Magic (2).

FRIDAY, OCTOBER 14.

UNIVERSITY COLLEGE, at 4.30.—Dr. J. C. Drummond: Nutrition (1).

SATURDAY, OCTOBER 15.

REGENT STREET POLYTECHNIC, at 10.30.—Prof. H. H. Turner: Modern Astronomical Theories.

MONDAY, OCTOBER 17

KING'S COLLEGE, at 5.30.—H. Moore: Liquid Fuels (1)

UNIVERSITY COLLEGE, at 5.—Prof. G. Dawes Hicks: The Philosophical Aspects of the Theory of Relativity.

TUESDAY, OCTOBER 18.

KING'S COLLEGE, at 5.30.—Prof. H. Wildon Carr: The Modern Scientific Revolution and its Meaning for Philosophy (2).—The Perceptual Basis of Physics.—Dr. W. Brown: Psychology and Psychotherapy (1).—L. J. Hunt: Cascade Synchronous Motors and Generators (1).

WEDNESDAY, OCTOBER 19.

KING'S COLLEGE, at 4.30.—Dr. C. Da Fano: Histology of the Nervous System (2).

CONTENTS.

	PAGE
The Aeronautical Research Committee	201
The Science of Pharmacognosy	203
Human Physiology. By E. P. C.	204
Principles of Electrical Engineering. By A. R.	205
Semi-popular British Botany. By R. R. G.	205
Our Bookshelf	206
Letters to the Editor:—	
Occurrence of the Aurora Line in the Spectrum of the Night Sky. — Right Hon. Lord Rayleigh, F.R.S.	208
Atomic Structure.—Prof. N. Bohr	208
The Separation of Chlorine into Isotopes.—Prof. William D. Harkins	209
The Pickering Series in O Type Stars.—H. H. Plaskett	209
Radiation and Chemical Action.—T. W. J. Taylor	210
Qualities of Valency.—Dr. R. M. Caven	210
The Dushman Equation for the Velocity of a Monomolecular Reaction.—W. E. Garner	211
The Duration of Sunrise and Sunset. (*With Diagram.*)—Dr. Willard J. Fisher	211
Is Bisexuality in Animals a Function of Motion?—G. C. Robson	212
An Algebraical Identity.—R. F. Whitehead	212
Consciousness and the Unconscious. By Prof. C. Lloyd Morgan, LL.D., D.Sc., F.R.S.	213
The Age of the Earth	217
The Constitution of Molecules	218
The Study of Bird-migration by the Marking Method. By W. E. C.	220
Obituary	221
Notes	222
Our Astronomical Column:—	
The Lunar Eclipse of Sunday, October 16	226
Morning Stars	226
Large Fireball	226
The Australian National Research Council	227
Scottish Fisheries. By Prof. W. C. McIntosh, F.R.S.	228
University and Educational Intelligence	229
Calendar of Scientific Pioneers	230
Societies and Academies	230
Books Received	231
Diary of Societies	232

THURSDAY, OCTOBER 20, 1921.

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London University Site.

THE public must be getting puzzled and bewildered over the question of the site for the University of London. Until recently it believed that the site at Bloomsbury had been definitely decided upon, and it expected that active preparations would shortly be made for the erection of buildings. There were good reasons for the belief and for the expectation. A public announcement was made that the Government's offer had been accepted, and that the purchase of the site had been completed. A few months later a temporary but very substantial building, provided by an anonymous donor at a cost of 20,000*l.*, for the University Institute of Historical Research, was actually erected on the Bloomsbury site and formally opened by the President of the Board of Education. This certainly looked as if the innumerable discussions and delays had at last resulted in something like definite action.

Before the summer vacation, however, the whole question was re-opened by the London County Council, which invited the Board of Education and the university to "explore the possibilities" of a site on the Holland Park estate before taking further action on the Bloomsbury site. The Council's resolution refers to the Holland Park site as "easily accessible from all parts of London, costing much less money, very much larger in area, and so affording room for expansion."

Any opinion expressed by the London County Council as the authority charged by Parliament with the promotion of higher education in London is entitled to be received with respectful consideration. It is difficult, however, to see what action the senate of the university can take. Before accepting the Government's offer of the Bloomsbury site the senate consulted the Council and was assured that in the event of the site being accepted the Council would consider making a building grant up to a third of a million pounds. Fortified with this expression of approval, the senate accepted the offer, and the sale was completed. It is impossible to withhold sympathy from a university which, having had one very valuable site presented to it, and having already partly acquired possession of it, is invited to "explore the possibilities" of another site which no one has offered to give. *Beati possidentes*: a non-academic body would have a ready answer, but it will probably be found that the senate of a university is not utterly lacking in worldly wisdom.

The fact that the Bloomsbury site has been accepted and is partially occupied is not of itself decisive. If a blunder has been made, it should be rectified. It is quite conceivable that there are better sites than that at Bloomsbury, but it is quite certain that Holland Park is not such an one, however diligently its possibilities are explored. The extent to which it is "easily accessible from all parts of London" may be seen by a moment's reference to a map. That it costs "much less money" is quite probable: it would probably cost even less if it were somewhat nearer than it is to Hammersmith and Shepherd's Bush. If this is the only serious alternative to the Bloomsbury site, there can be no doubt as to the result of exploring its possibilities, and time spent in doing so would be time wasted.

Too much time has, in our view, been wasted already. The need for a dignified home for the university is urgent and clamant.

It will not be met by suggestions to explore the possibilities of pleasant parks which happen to be without a building. The site must be central; it must be within easy reach of the great colleges and medical schools where the great bulk of the teaching is carried on; and it must be accessible to the hundreds of teachers and others who participate in the work of the university and the thousands of students who go up for its examinations. Up to the present the Bloomsbury site is the one that best complies with these requirements, and if it were not already "signed, sealed, and delivered," there are sufficient reasons why it should be.

Travel in North-west China.

Travels of a Consular Officer in North-west China. By Eric Teichman. Pp. xiv + 219 + 58 plates. (Cambridge: At the University Press, 1921.) 25*s.* net.

SHENSI and Kansu, in the remote north-western corner of China, are comparatively little known, for neither province has any railway or any town open to European trade. They are so far within Asia that they suffer from an arid climate and include large areas of typical loess land while they are traversed by the Ch'inling Mountains, the main mountain axis of Central China, which rise from the lower Hoang Ho to the Mongolian plateau. They range, therefore, from fertile lowlands to a high tableland, where the only extensive trade is in wool, with some alluvial gold-mining in deposits which the author's statements represent as comparatively rich.

Mr. Eric Teichman, of the British Consular Service, who is well known from his explorations in South-western China, made a tour of 4000 miles through the two provinces in 1917 in connection with the Opium Treaty. The conditions of travel were unusually favourable, as he had the privileges of a Chinese official, and he has used his opportunity to prepare two useful maps based on compass surveys, and to collect much valuable information as to the state of North-western China during a critical period. The author's remark, at the conclusion of the narrative of his journeys, that "the reader . . . is probably as tired of reading about them as the writer is of recording their description," indicates that the book is not light in style; but to those interested in China it contains much instructive information, and the chapters on the missionaries and on projected railways will interest a wider public.

The author's routes crossed both provinces in various directions, and extended to Chengtu, the capital of Szechuan, to the south-west. He returned by raft down the Hoang Ho. The most important contributions to science are in reference to loess and oil. The author's conclusions as to the formation of loess are unorthodox. He had excellent opportunities for studying it, and he rejects the theory of its formation by wind-borne dust. "The longer we travelled in the loess country," he says, "the more difficult it seemed to credit this theory." He attributes it to floods, and considers that its composition and distribution are in favour of an aqueous origin. The absence of fresh-water shells he dismisses as of no significance, since they are equally absent from loess which has certainly been re-deposited in water.

The author gives a brief but interesting account of the effort of the American Standard Oil Co., in accordance with a wide-reaching concession granted them in 1914, to develop an oil-field around Yenchang in northern Shensi. Two wells had been sunk there by Japanese, and they are still flowing and producing a considerable supply, which is used among other purposes as flares on the city walls in order to scare off brigands. The Standard Oil Co., after a promising preliminary report by its experts, made numerous bores, but found no further oil, and abandoned the concession in 1916.

Mr. Teichman's observations are most authoritative on the political condition of the country, on the projected railways, for which concessions have been granted to Belgian, Franco-Belgian, and American syndicates, and on the opium industry. He traversed the country when the recrudescence of opium-growing after the revolution of 1911 had been suppressed; but the preface reports that since his journey, in spite of the efforts of the Government, the cultivation of the poppy has again become widespread in Western China.

North-western China has a large Moslem population, due to two immigrations, the later of which occurred five or six centuries ago. The descendants of that movement are racially distinct, but those of the earlier colony are now physically Chinese. The author speaks highly of the influence of Islam, and regards the Moslem as superior to the adjacent Chinese. Though they are a minority of the population, they are so strong and so wisely led that they are allowed practically to govern themselves. Islam has inspired a native self-supporting sect, and the author holds it up as an example in that respect to the Christian missions. He expresses high praise for the secular and educational work of the Protestant missions, but of their religious work and sectarian jealousies, and of the political organisation of the Catholic missions, he is severely critical.

China is at present the prey to internal discord and civil war, and the author speaks of large areas being abandoned to sand and brigands. Shensi was devastated by the secret society of "White Wolves" in 1914, and has been the battleground between the northern and southern armies; but the author's numerous references to former civil wars and rebellions, and to the extension of trade and production, despite the present political feuds, justify the faith that the resources

of China, and the magnificent industry and intelligence of the Chinese, will enable the country once again to overcome difficulties that would be fatal to any State with a less stable economic foundation.

The book is illustrated by a series of excellent photographs. J. W. G.

Natural History of Pheasants.

A Monograph of the Pheasants. By William Beebe. (In four volumes.) Vol. 2. Pp. xv+269+plates. (London: H. F. and G. Witherby, 1921.) 12*l.* 10*s.*

THE first volume of this sumptuous and important work was noticed in NATURE for December 19, 1918, p. 302, and the long interval between its appearance and the issuing of the second instalment has been, the publishers point out, unavoidable, owing to various circumstances associated with the war.

The present volume treats of twenty-two species and of the hybrid forms of some of them: of the Kaleeges (genus Gennæus), of which there are ten species; the crestless firebacks (genus Acomus), two species; the crested firebacks (genus Lophura), four species; the white-tailed wattled pheasant (genus Lobiophasis), one species; and the junglefowls (genus Gallus), five species. All these genera are peculiar to the fauna of the Oriental regions. The life-histories and habits of a number of these birds were previously little or altogether unknown, owing to the difficulty of penetrating the dense jungles and forests which form their native haunts.

For many reasons the author considers the Kaleeges the most interesting members of the pheasant family, especially so on account of the very puzzling nature of the many forms, of which no fewer than thirty-five have been described either as species or as subspecies. Mr. Beebe has carefully studied these forms, with the result that he recognises only nine as full species, and the remaining twenty-six as natural hybrids. In Burma, where the range of three species (*Gennaeus lineatus, G. horsfieldi,* and *G. nycthemerus*) is conterminous, an astounding amount of hybridisation takes place. His researches have also added much to the knowledge of the home-life of several of the species. In like manner ornithology is indebted to him for his contributions to the histories of the crestless firebacks which inhabit the low-lying jungles of the Malay Peninsula and Sumatra, these in some cases being revealed only after great difficulties had been encountered. The same may be said of certain species of the crested firebacks, especially the Malayan species (*Lophura rufa*), a glimpse of the beauty of which, he tells us, was worth the longest stalk and the most wearisome wait. He was also successful in meeting with the gorgeous white-tailed wattled pheasant amid the upland jungles and low forests of Central Borneo. Regarding this species, Mr. Beebe rejoices that it has only one synonymic name, remarking that it is "a most welcome simplicity in nomenclature after such unfortunate taxonomic tangles as surround the specific identity of the species of Lophura." In this connection it may be noted that he has not made use of a single trinomial name in his great work.

The volume concludes with an account of the species of junglefowl, the typical form of which, *Gallus gallus,* the red junglefowl, is the parent stock of all the domestic breeds of poultry, and hence "to the human race . . . the most important bird on earth." This species is a native of India, Burma, Siam, Gambodia, the Malay States, and Sumatra, and is found in the wildest regions, as well as in close proximity to the wildest native villages. Through human agency it is now to be found in a more or less feral state in islands so far removed from its native haunts as Tahiti, but remains attributed to a species of Gallus have been discovered in deposits of Pleistocene age in New Zealand, while others of Pliocene age have been obtained in France and in Greece. If the identification of these fossil relics—not alluded to by Mr. Beebe—is to be relied upon, it is evident that junglefowls had a much wider range in prehistoric times. The Ceylon species (*G. lafayetti*) and the grey junglefowl (*G. sonnerati*) do not call for special mention. Perhaps the latter bird is best known on account of the fact that the terminal portion of its neck hackles are an almost indispensable adjunct to the modern salmon fly. With the fine and hitherto little-known Javan species it is otherwise, for there are some important facts associated with its geographical distribution, since it is the only species of the pheasant family treated of by the author the home of which is entirely confined to islands south of the equator. Moreover, it may be remarked, it is the only form the range of which extends into the Austro-Malay region, for it is a native of the islands of Lombok, Sumbawa, Flores, and Alor.

There have been many monographs devoted to various groups of birds, including the pheasants, not a few of which rank among the most beautiful works devoted to any branch of zoological science, but it is not too much to aver that the book under notice is incomparably the best. It may have been approached in the beauty of its

bird-portraiture, but its unrivalled merits are due to the original descriptions of the birds in their native surroundings, written by one who is intensely imbued with an all-round love of Nature, and endowed with a graceful pen—a combination which has imparted a fascination to the graphic descriptions of experiences in many cases unique. A number of the haunts were reached only after extraordinary difficulties had been overcome by the author's indomitable perseverance, and in the company of savages, some of whom were only "nominally safe." Thus were the facts respecting the home-life of certain little-known or wholly unknown species obtained, and the photographs of their abodes, which have been beautifully reproduced in photogravure, secured. The coloured plates, twenty-four in number, are excellent, especially those by Mr. G. E. Lodge and Mr. Grönvold, while a series of maps illustrating the distribution of the various species adds to the worth of a valuable and noteworthy contribution to ornithological literature. W. E. C.

Bütschli's Lectures on Comparative Anatomy.

Vorlesungen über vergleichende Anatomie. By Prof. Otto Bütschli. 3 Lieferung: *Sinnesorgane und Leuchtorgane.* Pp. iii+643–931+xiv. (Berlin: Julius Springer, 1921.) 48 marks.

THE first two parts of this text-book have already been reviewed in NATURE (in 1911, July 27, p. 104; and 1913, August 7, p. 577), and the distinctive merits of the work have been indicated. In the third part the excellence of the semi-diagrammatic illustrations and the lucidity of the exposition are fully maintained, although the author died in 1917, leaving the work unfinished. The difficult task of completing the work for this volume and seeing it through the press has been achieved with conspicuous success by Drs. Blochmann and Clara Hamburger.

The work deals with the sense-organs and the light-emitting mechanisms of both invertebrate and vertebrate animals, and, as in the preceding volumes, each structure is considered from a broad, comparative point of view, and illustrated with a wealth of diagrams. The reader can thus acquire easily a clear conception of the varied forms assumed throughout the animal kingdom by the series of sensory organs in the skin, the peripheral instruments of smell and taste, and the organs of equilibration, hearing, vision, and light-production. This method of treatment is of special interest and importance to the vertebrate morphologist. The latter experiences an increasing difficulty in discovering what is known about invertebrate anatomy, some of which often becomes of crucial importance in his researches. These considerations apply with special force to the sense-organs, and especially to those of vision, the understanding of the structure of which in invertebrate animals is essential for the adequate appreciation of the nature of the nervous arrangements in the eyes of vertebrates. The vast significance of the evolution of the sense-organs and their nervous connections with the evolution of vertebrate animals gives an additional interest to the text, supplemented as it is by the fascinating series of diagrams, which have been admirably chosen and clearly reproduced.

It is unfortunate that the authors, who must have sifted a vast array of writings in collecting the material for this volume, have omitted all bibliographical references, the inclusion of which would have trebled the value of the work. This is particularly to be regretted in the case of the light-emitting organs, for it is difficult for those who become interested in the elusive physico-chemical problems of these remarkable structures to get on to the track of the biological literature relating to them. G. ELLIOT SMITH.

Earth-structure.

Der Bau der Erde. By Prof. Leopold Kober. Pp. iv+324+2 plates. (Berlin: Gebrüder Borntraeger, 1921.) 80 marks.

THIS handsomely printed work, with a frontispiece, a folded map of general earth-structure, and line-illustrations in the text, is, in spite of its nominal price, a welcome sign of scientific recovery. The absence of an index is surely an accident which its well-known publishers will redress. Perhaps the most striking feature, and one that will encourage general use, is its crisp lucidity of style. We have selected at random ten consecutive sentences. They contain a total of 133 words, and one consists of six words only. This shows the German-Austrian language at its best, and we should like to attend Prof. Kober's lectures. His main thesis is that the building of folded mountain-chains is a process of "revolution" following on one of "evolution," in which geosynclinals have been formed. A geosynclinal represents what we sometimes regard as an epoch of quiescence. Its sinking base ultimately becomes nipped between two rigid masses of the lower crust, and the sedimentary accumulation rises in folds and overfolds at the surface. Mountain-building is the close of a cycle, and is a manifestation of the continuous contraction of the sub-

stance of the earth. A mountain-range denotes a lateral shrinkage of the outer crust. The portion of the earth that includes the geosynclinal masses and the resulting mountains is styled the "orogen"; the old and consolidated blocks are styled the "kratogen"—presumably because they exercise force upon the yielding orogen. All crust-disturbances originate in centripetal downward movement.

The immense part played by a forward movement that is largely gravitational is well shown in the treatment of the Alpine chains. Prof. Kober opposes the views of Suess as to the relationship of a general southward movement in Asia to a northward movement (a Rückfaltung) in Europe, and he urges that in both continents southerly and northerly thrusting may be traced. He introduces a number of useful conceptions. In the apparent absence of Mesozoic marine sediments round the Atlantic border he sees evidence of their recent submergence beneath the ocean. Africa is considered to be a vast block compressed within a ring provided by the Alpine orogen. Prof. Kober's treatise includes his own observations in the unfamiliar field of Syria, and his broad outlook maintains the tradition of the school inspired by Suess. Suess, continually revising his views in the light of later knowledge, raised more problems than even his long life could solve. We are still far from picturing earth-structure as bound by symmetry and rule.

GRENVILLE A. J. COLE.

Our Bookshelf.

Tychonis Brahe Opera Omnia. Tomi Quinti Fasciculus Prior: Astronomiae Instauratae Mechanica (1598); *In Solis et Lunae Motus Restitutos ac Sequens Diarium Prolegomena* (1598); *Specimen Diarii Anni* 1599 (1598); *Ephemerides Solis Annorum* 1586-1592. Pp. 213. (Kφbenhavn: Gyldendalske Boghandel, 1921.)

In this volume, or rather in this fasciculus, we are given some of the most interesting if not the most important works of Tycho Brahe. The title-page of the volume with the editor's name appears to be reserved for the second fasciculus, but it is probably safe to conjecture that the new volume, like its predecessors, has been produced by Dr. Dreyer. The first of these works was printed at Tycho Brahe's press at Wandsbek in the duchy of Holstein-Gottorp, where he was the guest of Heinrich of Rantzau. Thither he had transported his observations and most of his instruments in consequence of a disagreement with King Christian IV. which had led him to leave Denmark. He was now seeking a new patron, and his eyes turned to the Emperor Rudolf II., to whom this work is dedicated. It is in effect an attempt—as it happened, a successful attempt—on the part of the author to commend himself and his work to the emperor, and it contains an illustrated account of the structure and use of each of his instruments, an autobiography with an account of his achievements and projects, and an appendix describing his observatory at Hveen. The remaining works are now printed for the first time. The most important of them is the *Prolegomena*, which occupies twenty-five pages and treats generally the importance of the sun and moon in the universe and the corrections which the author has introduced into their theory.

On the whole it may be said that while these works do not contain any discovery which is not more fully treated elsewhere, they give us as good a conspectus as we could desire of his powers and achievements as an astronomer, and in the main his own judgment of his work is confirmed by the subsequent progress of science. His chief distinction lies in his genius in devising and his industry and ingenuity in using astronomical instruments, in which he stands immeasurably above all his predecessors. In his revision of constants and of theory he shows no genius, but a capacity which entitles him to rank next, perhaps, to Hipparchus and Copernicus. We shall doubtless be able to estimate his work better when the second fasciculus appears with the editor's notes.

J. K. F.

Icones Plantarum Formosanarum necnon et Contributiones ad Floram Formosanam. By Bunzō Hayata, Rigakuhakushi. Vol. 10. Pp. iv+335. (Taihoku: Bureau of Productive Industries, Government of Formosa, 1921.)

DR. HAYATA has devoted twenty years to the study of the vegetation of the island of Formosa, which, lying directly under the tropic of Cancer, and possessing mountain ranges rising more than 10,000 ft. above sea-level, presents almost every kind of climatal and topographical feature, with an extraordinarily rich flora embracing tropical, temperate, and even alpine elements. Climatic conditions and the activity of the head-hunters of the interior had restricted exploration to the coastal regions before the acquisition of the island by Japan. Dr. A. Henry's "List of Plants from Formosa" (1896), the first attempt to outline the flora, included 1428 species. This number has been nearly trebled by Dr. Hayata's efforts since his first visit to the island in 1900, and by later visits, as well as by his elaboration of collections made by other botanists. The present volume, the last of the series, includes an index to the ten volumes, comprising 3658 species of flowering plants and ferns, representing 1197 genera and 170 families. More than 1200 species are new, and among the new genera is the remarkable conifer, Taiwania. The volumes are profusely illustrated and form a very valuable contribution to the taxonomic study of an area of special interest.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Development of Optical Industries.

WE are asked by our principals, Messrs. Carl Zeiss, of Jena, to transmit the following observations on the leading article, "The Promotion of Our Optical Industries," which appeared in NATURE of February 10 last (vol. 106, p. 749), with the request that you would kindly extend to them in your columns the publicity which the importance of the subject deserves. It is regrettable that so long an interval should have been permitted to elapse, but we understand that the head of the department at Jena which deals with Press matters was absent from headquarters for several months :—

"To the leading article, 'The Promotion of Our Optical Industries,' which appeared in NATURE of February 10 last, some remarks present themselves which call into question the position assumed by the British Optical Instrument Manufacturers' Association. The article also contains some statements which are erroneous and call for correction.

"It would seem that the writer of this article was not perfectly acquainted with the history of English glass manufacture, for the words 'supremacy in the optical glass industry, which was established in this country as early as 1837,' are scarcely supported by an historical investigation. Such a supremacy did not then exist in England. It may perhaps be worth while to furnish some trustworthy historical data.

"When between 1825 and 1829 experiments on a very large scale were made in England, of which the Bakerian lecture given by Faraday at the end of 1829 was a detailed account, the position of English glass manufacture was not very flourishing, nor were the glasses of Benedictbeurn, near Munich, or those of les Brenets, in Neuchâtel, at that time obtainable in England. It would seem that even Faraday's energy was unable materially to alter that state of things, for his 'heavy glasses' were never largely employed for optical instruments in general. G. Bontemps's opinion that Faraday's experiments were discontinued, because later on ordinary optical glass was obtainable in France and in Switzerland, may possibly be correct. W. V. Harcourt's early experiments between 1834 and 1844 are very imperfectly known, but the result at that time was scarcely of any practical importance. G. G. Stokes, in any case, did not think much of the first specimens Harcourt sent in during 1862, and he attributed—very justly, one may think—a great part of the later remarkable scientific achievements (themselves without great practical value) to their united endeavours between 1862 and 1871. But these are matters of a much later period; we may, however, turn to the testimony of an English eyewitness of 1849, the telescope manufacturer, W. Simms, on the former state of English flint-glass manufacture. From his description we cannot infer anything of that English 'supremacy as early as 1837,' but must conclude that in England flint-glass for optical purposes had not been made commercially before the necessary technical knowledge was imported from France, when G. Bontemps came over to Chance's factory after 1848. After that time ordinary crown glass and ordinary flint-glass of good quality were put on the market in France, in Switzerland (by Th. Daguet in Solothurn up to the time of his death in 1870), and in England, the Munich factory working only for its proprietor, the optician Merz.

"This state of things was difficult to alter, as these few factories in thus practically monopolising the glass trade had no interest in making costly experiments for new kinds of glass for which no ready sale could be warranted. It was left to the man of science who demanded glasses with new properties to carry out the melting, and Abbe's and Schott's history shows how difficult it was to make the necessary scientific investigations. In order to facilitate industrial manufacture, the Prussian Government in 1883 contributed the sum of 60 000 marks (3000*l.*), whereas, according to Payen, the cost of Faraday's experiments had been 150,000 francs, equivalent to 6000*l.*, or even more if regard be paid to the then (1830) higher purchasing power of money. *Apart from that sum of* 3000*l. no State subsidy has ever been paid to the Jena glass factory,* nor was there any necessity for any further subsidy, for even the *optical* branch of the Jena glass factory of Schott und Gen. was financially successful. The idea that the manufacture of optical glass is impossible on a commercial basis finds further refutation in the fact that in 1893–94 Ch. E. Mantois, of Paris, began to melt the new kinds of glass for commercial purposes, and that a new German optical glass factory, Sendlinger optische Glaswerke G.m.b.H., was founded in 1913.

"Summing up the results, it is clear that English men of science of the highest standing were at work, and at least one of them—Faraday—was liberally assisted by the Government. That the success achieved did not come up to expectations may be attributed to the lack of a close and efficient co-operation such as existed between Abbe and Schott, which cannot be guaranteed by the cleverest institution.

"Another point in the article may well be questioned: 'If the British optical instrument industry is to be maintained and to develop so as to turn out products equal at least to the best products of other nations, it must not be dependent on foreign sources for the supply of optical glass, but must have an adequate home supply, equal, again, at least to the best available anywhere.'

"History does not point to the existence of such a very close relation between the welfare of the glass founder and of the optical instrument maker in the same country. Let us take, for instance, the history of the photographic objective, and this because we have here a modern instrument the history of which is sufficiently well known. The earliest (1840) invention of the first order belongs to Petzval, a mathematician in Vienna, who had to use French glass; a second invention, though devoid of commercial success (1843), belongs to the American engineer, A. S. Wolcott, who likewise had only French glass at his disposal. He was the first to publish a remarkable theory of the symmetrical lens, but it cannot be said that his discovery would have been improved by his having at his disposal raw material from an American factory. A. Steinheil bringing out his different series of aplanats and antiplanats between 1866 and 1881 may well be cited as an optician who was especially successful in his use of readily procurable foreign (French and English) glass. And when, finally, we arrive at the period of Jena glasses, we may point out that, apart from Zeiss's assistants, scientific men of no connection with Schott's factory, like E. von Hoëgh, A. Kerber, R. Steinheil, D. Kaempfer, etc., had to take the glasses from Schott as offered.

Amongst these a very important place must be reserved for H. Dennis Taylor, who constructed the very simple and very efficient type of the triplet, 'the Cooke lens,' or better 'lenses,' of the foreign material willingly placed at his disposal.

"Great opticians like Fraunhofer and Abbe were undoubtedly wanted in order to show to the incredulous optical world the necessity for new glasses by means of which different optical instruments could be brought to much higher efficiency; this feat having once been accomplished, the interest of the manufacturing optician and the glass founder are not nearly so closely connected as the writer of the article would appear to believe. We call to mind two characteristic instances where a founder, by pushing his own advantage too far, materially damaged the optician. In Munich, as was mentioned earlier, the optician Merz was proprietor also of the glassworks; his shortsighted exclusion of competitive opticians from the output of this factory was the real cause of the death from inanition of the oldest glass factory founded by Guinand and improved by Fraunhofer. On the other hand, the practical monopolisation of the glass market by French and English houses between 1848 and 1883 was certainly convenient from the founder's point of view, but it materially hampered the progress of the optical engineer. In the long run this shortsighted policy could not, however, prevent the establishing of more progressive glass manufactories, and this competition was undoubtedly in the interest of the optical manufacturer, although the old factories, showing less scientific initiative, suffered by it. The German optician certainly profited by this competition, but he did so in common with the foreign optician, whether American, Austrian, English, French, Italian, or Swiss.

"We do not hesitate to state that optical mathematicians of all countries will hail with strong approval every extension of the choice of glasses at their disposal, and deplore their exclusion—be the reason whatever it may—from any valuable material available to opticians in foreign countries."

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THE observations of Messrs. Carl Zeiss, of Jena, challenge the article, "The Promotion of Our Optical Industries," published in NATURE of February 10 last on three points:—(1) They deny what the article asserted, that supremacy in the optical glass industry passed over from this country to Germany, on the grounds that England never held supremacy in this industry. (2) They deny that State subsidies were made continuously to the optical glass industry in Germany from the time of the investigations of Schott and Abbe in 1881 down to the declaration of war in 1914; and they state categorically that, apart from a sum of 3000*l.* contributed by the Prussian Government in 1883, no State subsidy has ever been paid to the Jena glass factory. (3) They dispute the proposition that "if the British optical instrument industry is to be maintained and to develop so as to turn out products equal, at least, to the best production of other nations, it must not be dependent on foreign sources for the supply of optical glass, but must have an adequate home supply equal, again, at least to the best available anywhere."

(1) As to the first point, the "trustworthy historical data" supplied by Messrs. Carl Zeiss are incomplete and inconclusive. The article in NATURE did not assert that "supremacy" was established as early as 1837, but that the optical glass industry was established in this country in that year. The supremacy came later. It was not until 1848, when Bontemps left Choisy and came to Messrs. Chance's works, that Messrs. Chance Brothers were able to surmount the difficulties which surrounded the manufacture of optical glass. Such progress was afterwards made with the production of large meltings of uniform optical glass that the English firm quickly gained a very high reputation for the manufacture of large discs of optical glass of the finest quality for astronomical work. A few instances may be mentioned of their successful production of large telescope discs, that most severe test of the skill of the optical glass manufacturer.

At the Great Exhibition of 1851 the firm showed a 20-in. disc of light flint "for daguerreotype apparatus" and a 29-in. disc of dense flint, weighing 200 lb., for which a Council medal was awarded. In 1855 a companion crown disc was shown in Paris, and this Foucault pronounced to be the finest piece of glass he had ever seen. Discs of 24 in. and 29 in. were produced in 1856, and a pair of 18-in. discs sold to Messrs. Alvan Clark and Sons in 1860 resulted, during the testing of the object-glass made from them, in the discovery of the companion to Sirius. A pair of 26-in. discs, produced in 1862, were worked by Messrs. Cooke and Son, York, for Mr. R. S. Newall, into the largest refractor then in existence, and this was later given to Cambridge University. In 1871 and 1874 Messrs. Clark worked pairs of 26¼-in. discs, the former being used for the Washington refractor, with which the satellites of Mars were discovered. The 28-in. objective for Greenwich was finished by Sir Howard Grubb in 1887.

The question of the alleged supremacy of a particular country in any chosen industry may always be difficult of proof and largely a matter of opinion, but there is nothing in Messrs. Zeiss's detached historical data to invalidate, and much in the few facts we have just given to substantiate, the view that for some considerable period between 1848 and 1880 England held supremacy in the manufacture of optical glass. For a number of years from about 1880, during which period the discs for the great Lick and Yerkes telescopes were manufactured, Britain took a place second to that of France. It is significant that later in their letter Messrs. Zeiss speak of "the practical monopolisation of the glass market by French and English houses between 1848 and 1883."

(2) On the question of the subsidy the statement of Messrs. Zeiss must be accepted as authoritative, and we notice that it is limited to a State subsidy.

(3) But it is on the third point that issue can be directly joined with Messrs. Zeiss's arguments, which seem to suggest that the development of a national optical instrument industry is in no way dependent on, and would not be hampered by the absence of, an adequate home supply of optical glass. The instances they quote of advances in optical design and improvement in optical instruments prove nothing more than that dependence on a foreign supply for optical glass has not in the past entirely prevented some enterprising opticians and mathematicians from making distinct advances in optical design. But this is a far cry from establishing the proposition that a healthy and vigorous optical instrument industry has ever been, or can be, established in any country dependent entirely on foreign sources for its supply of optical glass. It is true that the British optical instrument industry has gained much since 1881 from its access to the products of Jena, but who shall estimate how much it has lost through the compara-

tive decline during that period of the optical glass manufacture in this country and the consequent absence of an active and close local *liaison* between the English mathematicians and opticians on one hand and the optical glass manufacturers on the other? The very presence in a country of an optical glass factory focusses interest on, and enlarges the conceptions of, the research problems connected with optical glass and its applications to optical instruments. The mathematicians and optical designers who are to open out new paths of advance should have the materials they need at hand and readily available. To allow the optical glass industry to die out in this country would mean that not only the spirit of invention in this industry, but also much of that spirit in the dependent industry of optical instrument manufacture, would pass over to the country in which there was close co-operation between these essentially related industries.

Messrs. Zeiss assert that the practical monopolisation of the glass market by French and English houses between 1848 and 1883 materially hampered the progress of the optical engineer. What reason have we to think that a similar monopolisation to-day by Germany would be less detrimental to the development of the optical instrument industry in this country? If Germany were the only source of supply of optical glass, what guarantee have we that preferential treatment would not be given to German optical manufacturers in matters of time, quality, and quantity, to the prejudice of optical manufacturers of other nations? Would the British engineering industry have reached its present excellence if there had been no efficient and vigorous iron and steel industry in this country, and consequently no continuous and intimate co-operation on the spot between the engineer and the iron and steel manufacturer? These considerations do not, of course, apply to all industries. But the optical instrument industry depends, and must depend, on constant and close co-operation and co-ordination between the optician and the mathematician on one hand and the manufacturer of optical glass on the other, and this cannot be complete and efficient in a country where the sole source of optical glass is a foreign supply.

We agree with Messrs. Zeiss's concluding statement that optical mathematicians of all countries need every extension of the choice of glasses at their disposal and would deplore their exclusion from any valuable material available to opticians in foreign countries. But there was no proposal in the article in NATURE of February 10 last designed or bound to have this effect, and, in any case, it leaves untouched the argument for maintaining, in the interests of British opticians, a healthy and progressive optical glass industry in this country.

THE WRITER OF THE ARTICLE.

The Tendency of Elongated Bodies to set in the North and South Direction.

AT one of the soirées of the Royal Society in 1920, Mr. A. E. Reeves showed an apparatus by means of which he believed he had obtained evidence that under suitable atmospheric conditions freely suspended elongated bodies set themselves with their longer axes in the geographical meridian. The evidence supplied at the time was not very convincing, and I understand that the subject is receiving further attention. In the meantime it may be pointed out that the earth's centrifugal force would act in a manner tending in the direction of the alleged effect, though the resulting couple is so minute that it would be extremely difficult to verify it experimentally.

If a horizontal rod be placed in the north and south direction, its southern end is—in the northern hemisphere—further away from the earth's axis. The centrifugal force is therefore greater at the southern end, and if the rod be slightly displaced, the horizontal component of that force will tend to bring the rod back into the meridian plane.

If ρ_0 be the distance of the centre of the rod from the earth's axis, that of a point at a distance s from the centre will be $\rho=\rho_0+s\cos\theta$, where θ is the co-latitude.

The horizontal component of the centrifugal force per unit mass at any point of the rod is $\omega^2\rho\cos\theta$. It is obvious that only the variation of the centrifugal force along the rod can produce an effect, so that we may write for its significant part $\omega^2 s\cos\theta$. If the rod be turned through an angle ϕ we must apply a further factor $\cos\phi$, neglecting small quantities of the second order. With σ for the mass per unit length of the rod, the couple acting on it becomes

$$\int \sigma\omega^2 s\cos^2\theta\sin\phi\cos\phi\,ds = I\omega^2\cos^2\theta\sin\phi\cos\phi,$$

where I is the moment of inertia of the rod about its centre of inertia. The result will be the same for any lamina, whatever its shape or material. For small values of ϕ the vibrations of the rod are determined by :—

$$I\frac{d^2\phi}{dt^2} = I\omega^2\cos^2\theta\,.\,\phi,$$

which gives the period of a complete oscillation as independent of I and equal to $2\pi/\omega\cos\theta$, or T sec θ, if T be the time of revolution of the earth. We find, therefore, that the suspended body tends to perform oscillations round the meridian position, the time of a complete oscillation being the same as that which Foucault's pendulum requires to turn round a complete circle, which in our latitude is about 31 hours.

The maximum torsional couple takes place when the rod is inclined at an angle of 45° to the meridian, and in a latitude of 45° it is $\frac{1}{4}I\omega^2$. If it be desired to demonstrate it experimentally we should naturally turn to quartz fibres on account of their great carrying power. According to Sir Richard Threlfall (*Phil. Mag.*, vol. 30, p. 99, 1890), a quartz fibre 0·001 cm. in diameter can carry about 10 grams. A uniform rod of that weight and 30 cm. in length has a moment of inertia 750. By a suitable distribution of the weight of the rod this might be increased to 1000. The numerical value of the resulting couple then becomes

$$250\,\omega^2 = 1{\cdot}3\times10^{-6}.$$

For the couple due to a unit angular torsion of a quartz thread of unit length and radius r, Sir Richard Threlfall gives $4{\cdot}7r^4\times10^{11}$. If the length of the thread be 47 cm., we find finally $1{\cdot}3\times10^{-4}$, or about 20 seconds of arc for the angular torsion of the thread which balances the couple due to centrifugal force. I believe that the finest threads have a diameter about ten times smaller than that in the example given, but the weights would then have to be divided by 100, and the angular displacement would be between three and four minutes of arc. It is to be noted further that the effect cannot be observed directly because we cannot remove or apply the centrifugal force at will; the whole apparatus would therefore have to be turned through an angle of 45°, and the difference measured between that angle and the angular displacement of the suspended body.

ARTHUR SCHUSTER.

Is Scientific Inquiry a Criminal Occupation?

I ASK the question because, under the provisions of the Safeguarding of Industries Act, 1921, which came into operation on October 1, scientific workers and the public may be fined one-third of the value on all scientific appliances and on all chemicals—other than sulphate of quinine—imported into this country. Why this quinine salt alone of all chemicals should be free I do not understand, unless it be because it is largely used as a contraceptive and the philanthropic framers of the Act are alive to the fact, which of all others is the most important for us to recognise, that our country has double the population it can carry. Obviously, they are bent on discouraging and hindering scientific inquiry in every possible way; the Act can have no other effect; only a small proportion of the articles it covers are, or ever will be, made in this country. No more iniquitous measure was ever passed into law.

I have given notice that at the next meeting of the council of the Chemical Society I will move that action be taken forthwith to secure the repeal of the Act. If it be not annulled, scientific workers generally must agree to boycott all apparatus and materials of English manufacture. For once we must wake up and show that we can both help ourselves and protect the interests of our country.

Sir William Pope, in a recent speech dealing with American conditions, pointed out that chemists at least were so organised in the U.S.A. that they could make their voice heard with effect in the legislature. Here the legislature, bureaucracy in general, does not care a rap for science. A request made by Sir William Pope several months ago to the Board of Trade, on behalf of the Federal Council, that the Council might be heard on the proposed Bill was never more than formally acknowledged.

If we believe in our craft and its national value we must be militant in its protection.

I shall be glad to receive names and addresses (written legibly on postcards, please) of those who are willing to join in a memorial to the Prime Minister. If we desire to gain a position for science in this country, it is our duty to show, for once, that we can do something—that we are not mere talkers.

HENRY E. ARMSTRONG.

55 Granville Park, Lewisham, London, S.E.13.

Radiation and Chemical Action.

As regards Prof. Lindemann's criticism of the radiation hypothesis of chemical reactions, namely, that exposure of an aqueous solution of sucrose *plus* acid to sunlight brings about no sensible increase in speed, two possible ways of meeting the criticism present themselves. The first is to assert that the absorbing power of the water—that is, its screening effect on the molecules of the reactant solutes—is so great that the effective radiation of sunlight is reduced to negligible dimensions in a thin layer. This suggestion was made by the present writer at the Faraday Society's discussion on September 28 last. In the light of Mr. Taylor's experiments, this suggestion is seen to be untenable. The alternative way of dealing with the criticism is based on the relatively small absorption capacity of the reactant solutes as suggested by Mr. McKeown and the present writer (Journ. Amer. Chem. Soc., p. 1304, June, 1921). In the paper referred to it is shown that a clear distinction must be drawn between photochemical and thermal conditions, the former involving an absorption coefficient term. Briefly, the treatment of the photochemical process is as follows:—

Consider a layer of sugar solution, cross-section 1 cm.^{2} and of thickness dx, at a temperature T_1. The number of molecules of sugar present is given by pdx/kT_1, where p is the osmotic pressure in absolute units. If the layer be acted on by black-body radiation of temperature T_2, the total energy of frequency ν absorbed per second is $2\alpha E_\nu . d\nu . dx$, where α is the absorption coefficient of the sugar. The chemically effective energy absorbed is a fraction γ of the above, namely,

$$\frac{4\pi\alpha\gamma h\nu^3}{c^2} \cdot e^{-h\nu/kT_2} \cdot d\nu \cdot dx.$$

This energy divided by $h\nu$ gives the number of sugar molecules decomposed photochemically per second, and therefore the fractional number decomposed in the layer per second is

$$\frac{4\pi\alpha\gamma\nu^2 kT_1}{c^2 p} \cdot e^{-h\nu/kT_2} \cdot d\nu.$$

For the action of sunlight this must be multiplied by $\theta^2/4 = 5{\cdot}42 \times 10^{-6}$, where θ is the apparent angular semi-diameter of the sun. Putting $\nu = 2{\cdot}86 \times 10^{14}$, $T_1 = 293°$ abs., $T_2 = 6000°$ abs., and $p = 22{\cdot}4/3{\cdot}42$ atmospheres (Taylor's experimental conditions), and giving to $d\nu$ the probable value 3×10^{13}, we get the fraction decomposed per second by the photochemical action to be $1{\cdot}06 \times 10^{-4}\ \alpha.\gamma$. The value of the *thermal* unimolecular velocity constant is approximately $4{\cdot}3 \times 10^{-6}$. Whilst actual data on the amount of absorption by the dissolved reactants are lacking, it is evident that the photochemical decomposition may readily be of the same order as the thermal effect, or even of a smaller order. It certainly does not exceed it by any such impossible magnitude as 10^{13}, and it is not surprising, therefore, that, with the very small time of exposure (about 1 second) given by Mr. Taylor to the droplets of the sugar solution, no appreciable change in the reaction velocity should have been observed.

A very rough estimate of the order of magnitude of $\alpha.\gamma$ may be obtained as follows:—In the first place, let us set $\gamma = 1$, its maximum value (in the case of anthracene γ has been estimated by Weigert as 0·04). As regards α, Coblentz has measured the percentage transmission of *solid* sugar in the infra-red region. In the neighbourhood of 1μ the value of α, obtained from Coblentz's data, is 46. In the case of 10 per cent. sugar solution the absorption coefficient, in so far as it depends on the sugar, would be reduced to about one-tenth of this value, corresponding to the ten-fold dispersion of the sugar molecules. Hence, in so far as these data are applicable, one would infer that the maximum value of $\alpha.\gamma$ does not exceed 5, thus making the photochemical fractional decomposition at most of the order 5×10^{-4}, which is 100 times the thermal for the acid strength employed by Mr. Taylor. As the thermal change in 1 second is quite inappreciable, it is possible for the photochemical change to be inappreciable also. (I omit, for the sake of brevity, consideration of the fact that the inversion of sugar is not a simple process, but involves at least three consecutive processes, so that the precise value of the effective wave-length has not as yet been ascertained.)

Finally, it may be pointed out that no determination of the amount of radiation absorbed by the sugar in the solution has as yet been carried out by Mr. Taylor. If this were small, no chemical change in excess of the thermal change would be anticipated.

W. C. McC. LEWIS.

Muspratt Laboratory of Physical and Electro-Chemistry, University of Liverpool.

Habits of the Hedgehog.

IN NATURE of May 19 last (pp. 375–76) you were good enough to notice at length my paper on "The Ancient Legend as to the Hedgehog carrying Fruit upon its Spines," published by the Manchester Literary and Philosophical Society (Memoirs, vol. 63, No. 2). That paper was written with a view to elicit further evidence for or against the truth of the legend, and for such I asked definitely. Unfortunately, so far no one has communicated such to me. I have, however, just found by accident in *Nature Notes* for 1904 (vol. 16) two records which I had overlooked, and as both are entirely to the point I desire to direct attention to them.

In one Mr. F. B. Doveton, of Karsfield, Torquay, well known as a poet and musician, writing (p. 118) to inquire whether or not there was any truth in the old legend, adds: "My gardener declares that he has *seen* the feat performed in an adjacent orchard." In the other Mr. W. H. Warner, of Fyfield, Abingdon, wrote (p. 152): "I well remember, many years ago, meeting with hedgehogs in an Oxfordshire orchard, to the spines of which several apples were sticking. The apples had adhered to the spines, I had little doubt, when the creatures were rolling under the trees. That the hedgehog climbs the apple-tree and carries off the fruit (as country people say it is in the habit of doing) is, of course, absurd."

One would like, of course, further details in corroboration of both these records, but, unfortunately, such are not forthcoming, the two gentlemen in question being now dead. One can, therefore, only note that there seems no reason whatever to doubt the perfect *bona fides* of either. One of the records is, it is true, second-hand, but it is contributed by a gentleman of known standing, who clearly was prepared to accept the truth of his informant's statement. The other is a perfectly definite first-hand statement by a contributor who was (I have ascertained) likely to be trustworthy as a field observer.

When writing my article I omitted to mention the not uninteresting fact that the hedgehog, under its old English name of "urchin," enters into the armorial bearings of several English families, either as a charge or as a crest—in the latter case generally on a "mount." Among these is that of Claxton, which bears as its crest an urchin sable, bezantée. The bezants represented originally, without doubt, apples or other fruit stuck upon its spines.

London, October 5. MILLER CHRISTY.

The Flight of Thistledown.

IT appears that fully blown thistledown in the sunshine has a positive lifting power, apart from any general upward current of the air. I shall be glad if any readers of NATURE can bring facts to confirm or contradict this statement.

Experiments that give the best result can be carried out as follows:—Find a thoroughly healthy thistle on which the seed is completely ripe and is in process of being shed. By means of tweezers liberate a tuft of the down, and without in any way injuring the symmetry of the whorl take off the seed and the style, which may be recognised through its darker colour. If the tuft in its uninjured condition is liberated in the sunshine on a level plane, it will be found to soar out of sight like a balloon.

One explanation may be that the sun in shining on the fine cilia warms them and creates a small local current of warm air.

I have found that swansdown, which appears to afford a much larger surface for a given weight than thistledown, does not have the same soaring power. I am not sure that the effect is purely thermal; it may be electrostatic. It is very important that the whorl should be undistorted.

When the tuft is loaded with a seed it appears to be almost neutral, with perhaps a slight lifting power under the best conditions. The whorl and seed in a slight wind will sometimes be carried for several hundred yards, falling and rising in the air-currents. Taking the weight of the seed at 0·5 of a milligram, it is easy to calculate how many tufts would be required to raise 1 ton! MILES WALKER.

College of Technology, Sackville Street, Manchester, September 29.

A Method of Improving Visibility of Distant Objects.

THE idea may have been suggested before, but I believe it is not generally known and appreciated how very much the power of distinguishing detail in a distant object, and especially of perceiving it in its natural colours, may be improved by the simple device of fitting a small Nicol's prism in the eye-piece end of the observing telescope. The Nicol serves to cut off a great deal of the blue atmospheric "haze" which usually envelops a distant view, and mostly consists of polarised light. Details which are usually lost in the haze, such as the colour of distant rocks or of the vegetation growing upon them, then stands out in a very striking way.

It may also be worth mentioning that the visibility of the horizon at sea, especially in a haze, may often be wonderfully improved by a similar device. In this case the result is due in part to a suppression of the reflection from the surface of the water as seen through the Nicol's prism.

It is hoped that these observations will not be merely a scientific curiosity, but may find a practical application. C. V. RAMAN.

S.S. *Narkunda*, near Aden, September 18.

Gold-coloured Teeth of Sheep.

IN NATURE of June 9 last (p. 459), recently arrived here, is a communication from Mr. W. J. Lewis Abbott concerning the metallic-looking encrustation occurring on the teeth of sheep. In Proc. Linnean Soc. N.S. Wales (vol. 45, 1920, p. 324), abstracted in NATURE of April 21 last (p. 249) and reprinted in full in the *Chemical News* (vol. 122, p. 49), I give a detailed report, with analyses, of this and similar deposits on the teeth of a number of other animals, including man. In no case is the deposit of a metallic nature, but consists entirely of a salivary encrustation composed usually mainly of phosphate of lime with organic matter. The metallic appearance is an optical effect due to the refraction of light by the overlapping thin lammellæ of the deposit.

I should be interested in examining Mr. Abbott's specimen if he will send me one, and reporting the result in NATURE. THOS. STEEL.

Stephens Street, Pennant Hills, New South Wales, August 11.

The Constitution of Molecules.

THE remarks attributed to me in NATURE of October 13 (p. 219) give an incorrect impression of what I intended to convey to the meeting. The statement that the molecular heats "are inconsistent with the arrangement which has been adopted to account for chemical valency" was not made.

J. R. PARTINGTON.

October 14.

The Laboratory of the Living Organism.[1]

By DR. M. O. FORSTER, F.R.S.

MANY and various are the reasons which have been urged, at different periods of its history, for stimulating the study of chemistry. In recent years these have been either defensive or frankly utilitarian, in the latter feature recalling the less philosophic aspects of alchemy; moreover, it is to be feared that a substantial proportion of those who have lately hastened to prepare themselves for a chemical career have been actuated by this inducement. It is the duty, therefore, of those who speak with any degree of experience to declare that the only motive for pursuing chemistry which promises anything but profound disappointment is an affection for the subject sufficiently absorbing to displace the attraction of other pursuits. Even to the young chemist who embarks under this inspiration the prospect of success as recognised by the world is indeed slender, but, as his knowledge grows and the consequent appreciation of our ignorance widens, enthusiasm for the beauty and mystery of surrounding nature goes far in compensating for the disadvantages of his position. Not only do chemical principles underlie the operations of every industry, but every human being—indeed, every living plant and animal—is, during each moment of healthy life, a practical organic and physical chemist, conducting analytical and synthetical processes of the most complex order with imperturbable serenity. No other branch of knowledge can appeal for attention on comparable grounds; and without suggesting that we should all, individually, acquire sufficient chemical understanding fully to apprehend the changes which our bodies effect so punctually and so precisely—for this remains beyond the power of trained chemists—it may be claimed that an acquaintance with the general outlines of chemistry would add to the mental equipment of our people a source of abundant intellectual pleasure which is now unfairly denied them. In following the customary practice of surveying matters of interest which have risen from our recent studies, therefore, it is the purpose of this address to emphasise also those æsthetic aspects of chemistry which offer ample justification for the labour which its pursuit involves.

What is breakfast to the average man? A hurried compromise between hunger and the newspaper. How does the chemist regard it? As a daily miracle which gains, rather than loses, freshness as the years proceed. For just think what happens. Before we reach the table frizzled bacon, contemplated or smelt, has actuated a wonderful chemical process in our bodies. The work of Pavlov has shown that if the dog has been accustomed to feed from a familiar bowl the sight of that bowl, even empty, liberates from the appropriate glands a saliva having the same chemical composition as that produced by snuffing the food. This mouth-watering process, an early experience of childhood, is known to the polite physiologist as a "psychic reflex," and the various forms assumed by psychic reflex, responding to the various excitations which arise in the daily life of a human being, must be regarded by the chemical philosopher as a series of demonstrations akin to those which he makes in the laboratory, but hopelessly inimitable with his present mental and material resources. For, extending this principle to the other chemical substances poured successively into the digestive tract, we have to recognise that the minute cells of which our bodies are co-ordinated assemblages possess and exercise a power of synthetic achievement contrasted with which the classical syntheses, occasionally enticing the modern organic chemist to outbursts of pride, are little more than hesitating preliminaries. Such products of the laboratory, elegant as they appear to us, represent only the fringe of this vast and absorbing subject. Carbohydrates, alkaloids, glucosides, and purines, complex as they seem when viewed from the plane of their constituent elements, are but the molecular debris strewing the path of enzyme action and photochemical synthesis, whilst the enzymes produced in the cells, and applied by them in their ceaseless metamorphoses, are so far from having been synthesised by the chemist as to have not even yet been isolated in purified form, although their specific actions may be studied in the tissue-extracts containing them.

Reflect for a moment on the specific actions. The starch in our toast and porridge, the fat in our butter, the proteins in our bacon, all insoluble in water, by transformations otherwise unattainable in the laboratory are smoothly and rapidly rendered transmissible to the blood, which accepts the products of their disintegration with military precision. Even more amazing are the consequences. Remarkable as the foregoing analyses must appear, we can dimly follow their progress by comparison with those more violent disruptions of similar materials revealed to us by laboratory practice, enabling such masters of our craft as Emil Fischer to isolate the resultant individuals. Concurrently with such analyses, however, there proceed syntheses which we can scarcely visualise, much less imitate. The perpetual elaboration of fatty acids from carbohydrates, of proteins from amino-acids, of zymogens and hormones as practised by the living body are beyond the present comprehension of the biochemist; but their recognition is his delight, and the hope of ultimately realising such marvels provides the dazzling goal towards which his efforts are directed.

[1] Abridged from the presidential address delivered to Section B (Chemistry) of the British Association at Edinburgh on September 8.

The Vegetable Alkaloids.

It should not be impossible to bring the skeleton of these transformations within the mental horizon of those who take pleasure in study and reflection; and to those also the distinction between plants and animals should be at least intelligible. The wonderful power which plants exercise in building up their tissues from carbonic acid, water, and nitrogen, contrasted with the powerlessness of animals to utilise these building materials until they have been already assembled by plants, is a phenomenon too fundamental and illuminating to be withheld, as it now is, from all but the few. For by its operation the delicate green carpet, which we all delight in following through the annual process of covering the fields with golden corn, is accomplishing throughout the summer months a vast chemical synthesis of starch for our benefit. .Through the tiny pores in those tender blades are circulating freely the gases of the atmosphere, and from those gases—light, intangible nothingness, as we are prone to regard them—this very tangible and important white solid compound is being elaborated. The chemist cannot do this. Plants accomplish it by their most conspicuous feature, greenness, which enables them to put solar energy into cold storage; they are accumulating fuel for subsequent development of bodily heat energy. Side by side with starch, however, these unadvertised silent chemical agencies elaborate molecules even more imposing, in which nitrogen is interwoven with the elements of starch, and thus are produced the vegetable alkaloids.

In this province the chemist has been more fortunate, and successive generations of students have been instructed in the synthesis of piperine, coniine, trigonelline, nicotine, and extensions from the artificial production of tropine; but until quite recently his methods have been hopelessly divergent from those of the plant. Enlightening insight into these, however, was given just four years ago by R. Robinson, who effected a remarkably simple synthesis of tropinone by the mere association of succindialdehyde, methylamine, and acetone in water, unassisted by a condensing agent or an increase of temperature. Based upon this experiment, R. Robinson (1917) has developed an attractive explanation of the phytochemical synthesis of alkaloids, in which the genesis of a pyrrolidine, piperidine, quinunuclidine, or *iso*-quinoline group is shown to be capable of proceeding from the association and interaction of an amino-acid, formaldehyde, acetonedicarboxylic acid and the intermediate products of these, taking place under the influence of oxidation, reduction, and condensation such as the plant is known to effect. Thus it may be claimed that Robinson's theory represents a notable advance in our conception of these vital changes, and that by means of the carbinolamine and aldol condensations involved fruitful inquiries into constitution and the mechanism of synthesis will follow.

The Nucleic Acids.

Owing to the venerable position occupied by alkaloids in the systematic development of chemical science, and to the success which has attended elucidation of their structure, many of us have become callous to the perpetual mystery of their elaboration. Those who seek fresh wonders, however, need only turn to the nucleic acids in order to satisfy their curiosity. For in the nucleic acid of yeast the chemist finds a definite entity forming a landmark in the path of metabolic procedure, a connecting link between the undefined molecules of living protein and the crystallisable products of katabolic disintegration. In the language of chemistry it is a combination of four nucleotides, linked with one another through the pentose molecule, *d*-ribose, which is common to each, and owing its acid character to phosphoric acid, also common to the component nucleotides. The latter differ from one another in respect of their nitrogenous factors, which are guanine (2-amino-6-oxypurine), adenine (6-aminopurine), uracil (2 : 6-dioxypyrimidine), and cytosine (2-oxy-6-aminopyrimidine), giving their names to the four nucleotides. The transformations undergone by nucleic acid in contact with tissue extracts have provided the subjects of numerous investigations extending over thirty years. In fact, the experimental material is of such voluminous complexity as to be unintelligible without the guidance of an expert, and in this capacity W. Jones has rendered valuable service by his recent lucid arrangement of the subject (1921). From this it is comparatively easy to follow the conversion of nucleic acid into uric acid through the agency of enzymes, and a review of these processes can serve only to increase our admiration for the precision and facility with which the chemical operations of the living body are conducted.

Considerable progress has been made also in localising the various enzymes among the organs of the body, particularly those of animals. Into the results of these inquiries it is not the purpose of this address to enter further than to indicate that they reveal a marvellous distribution, throughout the organism, of materials able to exert at the proper moment those chemical activities appropriate to the changes which they are required to effect. The contemplation of such a system continuously, and in health unerringly, completing a series of chemical changes so numerous and so diverse must produce in every thoughtful mind a sensation of humble amazement. The aspect of this miraculous organisation which requires most to be emphasised, however, is that an appreciation of its complex beauty can be gained only by those to whom at least the elements of a training in chemistry have been vouchsafed. Such training has potential value from an ethical standpoint, for chemistry is a drastic leveller; in the nucleic acids man discovers a kinship with yeast-cells, and in their common failure to transform uric acid into allantoin he finds a fresh bond of sympathy with apes. The

overwhelming majority of people arrive at the grave, however, without having had the slightest conception of the delicate chemical machinery and the subtle physical changes which, throughout each moment of life, they have methodically and unwittingly operated.

Chlorophyll and Haemoglobin.

To those who delight in tracing unity among the bewildering intricacies of natural processes, and by patient comparison of superficially dissimilar materials triumphantly to reveal continuity in the discontinuous, there is encouragement to be found in the relationship between chlorophyll and hæmoglobin. Even the most detached and cynical observer of human failings must glow with a sense of worship when he perceives this relationship, and thus brings himself to acknowledge the commonest of green plants among his kindred. Because, just as every moment of his existence depends upon the successful performance of its chemical duties by the hæmoglobin of his blood corpuscles, so the life and growth of green plants hinge on the transformations of chlorophyll. The persevering elucidation of chlorophyll structure ranks high in the achievements of modern organic chemistry, and in its later stages is due principally to Willstätter and his collaborators, whose investigations culminated in 1913.

This is not an occasion to follow, otherwise than in the barest outline, the course of laboratory disintegration to which the chlorophyll molecules have been subjected by the controlled attack of alkalis and acids. The former agents reveal chlorophyll in the twofold character of a lactam and a dicarboxylic ester of methyl alcohol and phytol, an unsaturated primary alcohol, $C_{20}H_{39}.OH$, of which the constitution remains obscure in spite of detailed investigation of its derivatives; but the residual complex, representing two-thirds of the original molecule, has been carefully dissected. The various forms of this residual complex, when produced by the action of alkalis on chlorophyll, have been called "phyllins"; they are carboxylic acids of nitrogenous ring-systems, which retain magnesium in direct combination with nitrogen. The porphyrins are the corresponding products arising by the action of acids; they are carboxylic acids of the same nitrogenous ring-systems from which the magnesium has been removed. The phyllins and the porphyrins have alike been degraded to the crystalline base, ætioporphyrin, into the composition of which four variously substituted pyrrole rings enter. It is this assemblage of substituted pyrroles which, according to present knowledge, is the basic principle also of the blood-pigment, in which iron plays the part of magnesium in chlorophyll.

Anthocyans, the Pigments of Blossoms and Fruits.

Since the days of Eden, gardens have maintained and extended their silent appeal to the more gentle emotions of mankind. The subject possesses a literature, technical, philosophical, and romantic, at least as voluminous as that surrounding any other industrial art, and the ambition to cultivate a patch of soil has attracted untold millions of human beings. Amongst manual workers none maintains a standard of orderly procedure and patient industry higher than that of the gardener. Kew and La Mortola defy the power of word-painters to condense their soothing beauty into adequate language, whilst that wonderful triangle of cultivation which has its apex at Grasse almost might be described as industry with a halo.

Prior to 1913 the most fruitful attempt to isolate a colouring-matter from blossoms in quantity sufficient for detailed examination had been made by Grafe (1911), but the conclusions to which it led were inaccurate. In the year mentioned, however, Willstätter began to publish with numerous collaborators a series of investigations, extending over the next three years, which have brought the subject within the realm of systematic chemistry. For the purpose of distinguishing glucosidic and non-glucosidic anthocyans the names anthocyanin and anthocyanidin respectively were applied. The experimental separation of anthocyanins from anthocyanidins was effected by partition between amyl alcohol and dilute mineral acid, the latter retaining the diglucosidic anthocyanins in the form of oxonium salts and leaving the anthocyanidins quantitatively in the amyl alcohol, from which they are not removed by further agitation with dilute acid; the monoglucosidic anthocyanins were found in both media, but left the amyl alcohol when offered fresh portions of dilute acid.

The earliest of these papers, published in conjunction with A. E. Everest, dealt with cornflower pigments, and indicated that the distinct shades of colour presented by different parts of the flower are caused by various derivatives of one substance; thus the blue form is the potassium derivative of a violet compound which is convertible into the red form by oxonium salt-formation with a mineral or plant acid. Moreover, as found in blossoms, the chromogen was observed to be combined with two molecular proportions of glucose and was isolated as crystalline cyanin chloride; hydrolysis removed the sugar and gave cyanidin chloride, also crystalline. Applying these methods more generally, Willstätter and his other collaborators have examined the chromogens which decorate the petals of rose, larkspur, hollyhock, geranium, salvia, chrysanthemum, gladiolus, ribes, tulip, zinnia, pansy, petunia, poppy, and aster, whilst the fruit-skins of whortleberry, bilberry, cranberry and cherry, plum, grape, and sloe have also been made to yield the pigment to which their characteristic appearance is due.

Micro-biochemistry.

Amongst the many sources of pleasure to be found in contemplating the wonders of the universe, and denied to those untrained in scientific

principles, is an appreciation of infra-minute quantities of matter. It may be urged by some that within the limits of vision imposed by telescope and microscope, ample material exists to satisfy the curiosity of all reasonable people, but the appetite of scientific inquiry is insatiable, and chemistry alone, organic, inorganic, and physical, offers an instrument by which the investigation of basal changes may be carried to regions beyond those encompassed by the astronomer and the microscopist.

It is not within the purpose of this address to survey that revolution which is now taking place in the conception of atomic structure. Fortunately for our mental balance the discoveries of the current century, whilst profoundly modifying the atomic imagery inherited from our predecessors, have not yet seriously disturbed the principles underlying systematic organic chemistry; but they emphasise in a forcible manner the intimate connection between different branches of science, because it is from the mathematical physicist that these new ideas have sprung. Their immediate value is to reaffirm the outstanding importance of borderline research and to stimulate interest in submicroscopic matter. This interest presents itself to the chemist very early in life and dominates his operations with such insistence as to become axiomatic. So much so that he regards the universe as a vast theatre in which atomic and molecular units assemble and interplay, the resulting patterns into which they fall depending on the physical conditions imposed by Nature. This enables him to regard micro-organisms as co-practitioners of his craft, and the chemical achievements of these humble agents have continued to excite his admiration since they were revealed by Pasteur.

Lamenting as we now do so bitterly the accompaniments and consequences of war, it is but natural to snatch at the slender compensations which it offers, and not the least among these must be recognised the stimulus which it gives to scientific inquiry. Pasteur's *Etudes sur la Bière* were inspired by the misfortunes which overtook his country in 1870–71, and the now well-known process of Connstein and Lüdecke for augmenting the production of glycerol from glucose was engendered by parallel circumstances. That acquaintance with the yeast-cell which was an outcome of the former event had, by the time of the latter discovery, ripened into a firm friendship, and those who slander the chemical activities of this genial fungus are defaming a potential benefactor. Equally culpable are those who ignore them. If children were encouraged to cherish the same intelligent sympathy with yeast-cells which they so willingly display towards domestic animals and silkworms, perhaps there would be fewer crazy dervishes to deny us the moderate use of honest malt-liquors and unsophisticated wines, fewer pitiable maniacs to complicate our social problems by habitual excess.

Conclusion.

In "The Salvaging of Civilisation," H. G. Wells has lately directed the attention of thoughtful people to the imperative need of reconstructing our outlook on life. Convinced that the state-motive which, throughout history, has intensified the self-motive must be replaced by a world-motive if the whole fabric of civilisation is not to crumble in ruins, he endeavours to substitute for a League of Nations the conception of a World State. In the judgment of many quite benevolent critics his essay in abstract thought lacks practical value because it underestimates the combative selfishness of individuals. Try to disguise it as one may, this quality is the one which has enabled man to emerge from savagery, to build up that most wonderful system of colonial organisation, the Roman Empire, and to shake off the barbaric lethargy which engulfed Europe in the centuries following the fall of Rome. The real problem is how to harness this combative selfishness. To eradicate it seems impossible, and it has never been difficult to find glaring examples of its insistence among the apostles of eradication. Why cry for the moon? Is it not wiser to recognise this quality as an inherent human characteristic, and whether we brand it as a vice or applaud it as a virtue endeavour to bend it to the elevation of mankind? For it could so be bent. Nature ignored or misunderstood is the enemy of man; Nature studied and controlled is his friend. If the attacking force of this combative selfishness could be directed, not towards the perpetuation of quarrels between different races of mankind, but against Nature, a limitless field of patience, industry, ingenuity, imagination, scholarship, aggressiveness, rivalry, and acquisitiveness would present itself; a field in which the disappointment of baffled effort would not need to seek revenge in the destruction of our fellow-creatures: a field in which the profit from successful enterprise would automatically spread through all the communities. Surely it is the Nature-motive, as distinct from the state-motive or the world-motive, which alone can salvage civilisation.

Before long, as history counts time, dire necessity will have impelled mankind to some such course. Already the straws are giving their proverbial indication. The demand for wheat by increasing populations, the rapidly diminishing supplies of timber, the wasteful ravages of insect pests, the less obvious, but more insidious depredations of our microscopic enemies, and the blood-curdling fact that a day must dawn when the last ton of coal and the last gallon of oil have been consumed, are all circumstances which, at present recognised by a small number of individuals comprising the scientific community, must inevitably thrust themselves upon mankind collectively. In the campaign which then will follow, chemistry must occupy a prominent place because it is this branch of science which deals with matter more intimately than any other, revealing its properties,

its transformations, its application to existing needs, and its response to new demands. Yet the majority of our people are denied the elements of chemistry in their training, and thus grow to manhood without the slightest real understanding of their bodily processes and composition, of the wizardry by which living things contribute to their nourishment and to their æsthetic enjoyment of life.

It should not be impossible to bring into the general scheme of secondary education a sufficiency of chemical, physical, mechanical, and biological principles to render every boy and girl of sixteen possessing average intelligence at least accessible by an explanation of modern discoveries. One fallacy of the present system is to assume that relative proficiency in the inorganic branch must be attained before approaching organic chemistry. From the point of view of correlating scholastic knowledge with the common experiences and contacts of daily life this is quite illogical; from baby's milk to grandpapa's Glaxo the most important things are organic, excepting water. Food (meat, carbohydrate, fat), clothes (cotton, silk, linen, wool), and shelter (wood) are organic, and the symbols for carbon, hydrogen, oxygen, and nitrogen can be made the basis of skeleton representations of many fundamental things which happen to us in our daily lives without first explaining their position in the periodic table of all the elements. The curse of mankind is not labour, but waste; misdirection of time, of material, of opportunity, of humanity.

Realisation of such an ideal would people the ordered communities with a public alive to the verities, as distinct from irrelevancies of life, and apprehensive of the ultimate danger with which civilisation is threatened. It would inoculate that public with a germ of the Nature-motive, producing a condition which would reflect itself ultimately upon those entrusted with government. It would provide the mental and sympathetic background upon which the future truth-seeker must work, long before he is implored by a terrified and despairing people to provide them with food and energy. Finally, it would give an unsuspected meaning and an unimagined grace to a hundred commonplace experiences. The quivering glint of massed bluebells in broken sunshine, the joyous radiance of young beech-leaves against the stately cedar, the perfume of hawthorn in the twilight, the florid majesty of rhododendron, the fragrant simplicity of lilac, periodically gladden the most careless heart and the least reverent spirit; but to the chemist they breathe an added message, the assurance that a new season of refreshment has dawned upon the world, and that those delicate syntheses, into the mystery of which it is his happy privilege to penetrate, once again are working their inimitable miracles in the laboratory of the living organism.

Metaphysics and Materialism.

By PROF. H. WILDON CARR.

"IF the illusion of the scholastic method is that from mere forms we can deduce essences, then the world-view which we call materialism is only a scholastic pastime." This is the concluding sentence of Hermann Weyl's "Raum, Zeit, Materie." Whatever may be the case with the physicists, the mathematicians are under no illusion with regard to the completeness of the scientific revolution. The principle of relativity has not merely complicated the concept of physical reality; it has re-formed it. Mathematics is, and has always been recognised as being, a constructive process of the human mind exercised on physical existence. The old mathematics took its matter from physics; the new mathematics gives matter to physics. The effect is that the world-view which had become for physical science in the nineteenth century practically unchallengeable, and the acceptance of which had come to be regarded as the indispensable condition and only passport for those who would enter the ranks of scientific investigators, has become suddenly incredible. It is true, indeed, that it still has its defenders, and that it is held as firmly as ever by many who continue to be in their special departments authoritative teachers; but this does not alter the fact that for us to-day the world-view is changed, and it is not even strange that many leaders in scientific research still cling fast to the old view when we remember that the great originator of the modern inductive method in the seventeenth century, Francis Bacon, to the end rejected the Copernican theory.

Materialism does not stand for any particular theory of the nature of matter, but for the general world-view that matter, something *de facto* objective the ultimate constitution of which we may not know, and even may not be able to know, but which is entirely independent of our reason and of any thoughts we may have about it, exists and constitutes the reality of the universe, including reason and will, which as qualities or properties of some of its forms give rise to knowledge of it. This materialism reached the zenith of its expression in the Darwinian theory of natural selection, not in that theory itself, the truth of which there is no intention in this connection to call in question, but in the implications which were generally accepted as contained in it, and especially in the application which was made of it to rationalise a world-view. It seemed to point a way by which it was possible to conceive, and to some extent to follow in its history, an evolution which had produced mind from an original matter.

It may not be obvious at once that the mere rejection of the Newtonian concept of absolute space and time and the substitution of Einstein's

space-time is the death-knell of materialism, but reflection will show that it must be so. If space is not endless, but finite (and this is the essential principle of the Riemannian geometry), and if time is not in its existence independent of space, but co-ordinate with the spatial dimensions in the space-time system (and this is the essential principle of the concept of the four-dimensional continuum), then the very foundation of the materialistic concept is undermined. For the concept of relative space-time systems the existence of mind is essential. To use the language of philosophy, mind is an *a priori* condition of the possibility of space-time systems; without it they not only lose meaning, but also lack any basis of existence. The co-ordinations presuppose the activity of an observer and enter into the constitution of his mind. If you distinguish, as, of course, you must and do, the observer from his space-time system, it is not a distinction of two separate existences externally related; they exist only in their relation, as when, for example, we distinguish an activity from its expression.

This is not a metaphysical gloss on a scientific principle, nor is it an attempt, as some may think, to obstruct the clear path of scientific progress with speculative cobwebs; it is the plainest matter of fact. Everyone who ignores it will simply find himself left stranded, unable to play any part in the conquest of the new realm opening before science.

In fact, it is not from philosophy, but from science, that this rejection of materialism comes. No one has expressed it with greater force and with fuller conviction of its fundamental importance than Prof. Weyl. In the introduction to the book which I have quoted, the whole of which is devoted to an exposition of the principle of relativity, he says:—

> Whatever *matter* might ultimately prove to be, one thing we have always felt we knew for certain: that it is a substance underlying all change, and that every bit of matter could be measured as a quantity. Its substantial character found expression in a law of conservation. We believed the quantity of matter remained constant throughout all change. Till now philosophy has usually regarded this as *a priori* knowledge, unrestricted alike in its generality and in its necessity. To-day the certainty is changed to doubt. After physics in the hands of Faraday and Maxwell had set up another character, the *field*, above that of matter, and after mathematics on the other side, burrowing during the last century in a logical exploration beneath the basis of Euclidean geometry, had destroyed our confidence in its evidence, there has burst in our days a revolutionary storm which has swept away the ideas of space and time and matter, which till now had been the firmest supports of natural knowledge,—only, however, to make room for a freer and deeper insight into things.

Materialism is essentially a monistic and atomistic conception of reality. For it matter is primordial, and mind is derived. Philosophers from the beginning of philosophy have been conscious of the intellectual difficulty of such a concept, but it has always seemed, even to philosophers, a necessary presupposition of physical science. Science, it was conceded, must at least proceed *as if* it were so. The principle of relativity is the rejection of it, a rejection based on the discovery, not of theoretical difficulties, but of practical matters of fact. The supposed fundamental reality on which materialism as a world-view was supported has proved a vain illusion, and materialism is left in the air. The new scientific conception of the universe is monadic. The concrete unit of scientific reality is not an indivisible particle adversely occupying space and unchanging throughout time, but a system of reference the active centre of which is an observer co-ordinating his universe. The methodological difference between the old and the new is that mathematics is a material, and no longer a purely formal, science.

Damascene Steel and Modern Tool Steel.

THREE years ago Col. N. T. Belaiew presented to the Iron and Steel Institute the results of a very careful study of the general properties and structure of Damascene steel, and pointed out the great claims it had to the attention of all those interested in tool steel. He has now contributed a second paper, entitled "Damascene Steel," to the proceedings of the institute, September, 1921, in which an endeavour is made to substantiate this statement, especially as regards high-speed steels. In his view a marked analogy exists in the structure and also in some of the properties of both types of steel, and a comparative study, therefore, will probably prove beneficial in explaining the properties of these materials and improving the qualities of existing rapid-cutting tools.

Damascene steel belongs to the hypereutectoid series of carbon steels with an average content of about 1·5 per cent. of carbon. This carbon exists as iron carbide, Fe_3C, the well-known cementite; 1·5 per cent. of carbon represents 22·5 per cent. of cementite; about one-half of this is present with ferrite as the eutectoid pearlite; the remainder forms excess or free cementite. Of this the latter is distinctly the coarser, and in order to globularise or spheroidise the plates in which it exists in the casting, repeated careful hammering and heating are necessary. In this operation the plates are first broken down into small, irregularly shaped crystals, and are afterwards spheroidised, being of such a size that surface tension is able to exercise a marked influence on their ultimate form. The completeness of this spheroidisation is shown in the photomicrograph of an Indian Damascene blade contained in the author's paper, in which the large spheroids have resulted from free cementite, while

the small ones have been obtained from the eutectoid cementite. In the author's first paper it was shown that a large amount of mechanical treatment was needed in order to produce this complete spheroidisation. The macrostructure shows that the cementite vein runs close up to the edge, and the Oriental maker must have relied most upon securing the best cutting properties in the cementite particles.

High-speed tool steel, which is an alloy steel containing from 16 to 20 per cent. of tungsten and from 3 to 5 per cent. of chromium, in addition to a carbon content not exceeding 0·75 per cent., together with vanadium up to 1 per cent., also belongs to the cementitic series of steels, and its structure in the annealed condition is strikingly similar to that of Damascene steel. Spheroidised carbide particles are embedded in a sorbitic matrix. To produce the characteristic high-speed hardness such steels have to be heated to incipient melting and then rapidly cooled in a current of air. Even after this treatment a certain amount of carbide remains undissolved, and there are indications that a moderate amount of it increases the cutting properties of the tool. What is important to notice is that the makers of high-speed steel emphasise the necessity of producing a particular type of structure under the hammer, and that during this operation the massive carbides and tungstides present in the ingot are broken down and uniformly distributed through it. Accordingly the ingots are first hammered into billets, and the latter are reheated and hammered a second time. This double treatment is indispensable and must precede the heat treatment proper by thoroughly breaking up and distributing evenly the carbides and tungstides throughout the steel.

Col. Belaiew then compares not only the structures, but also the respective processes of manufacture, and points out how similar they are. Both start with a cementitic steel; both require the greatest care in breaking and evenly distributing the carbides under the hammer; in both cases the amount of mechanical work done on a given article is very large; in both cases the structure of the resulting carbides is globular or spherulitic, while the matrix is martensitic; in both cases the cutting properties of the edge depend both on the matrix and the carbides, and the author is disposed to think that the *rôle* of the latter is the more important of the two. His studies in this field have led him to the belief that the workers in Damascene steel, while very strict as regards the hammering temperatures, did not lay anything like so much stress on the subsequent heat treatment.

In Damascene steel the degree of spheroidisation is always very high. This was not an end in itself, but was attained incidentally by the numerous cautious forgings and heatings which were designed to produce the greatest ductility possible. In high-speed tool steels spheroidisation is also attained, but the author holds that insufficient stress has been laid on this point by both makers and users, and that the scientific application of the spheroidising process would help to improve the qualities of existing steels. He considers also that another inference might be drawn from the Damascene process, namely, the proper study of the macrostructure in all cases. An Oriental maker would never manufacture a steel article without having satisfied himself by studying the "watering" that the distribution of the carbide particles was the best possible and in accordance with the shape and properties of the article. Neither would he find a buyer ready to accept a sword or a tool without a proper metallographic examination of it as a whole, and to this the Oriental watering lent itself well. The author suggests, therefore, that a proper examination of the watering of high-speed steel, whether in billets or in the finished article, should prove useful. It is interesting to notice that he found a certain degree of high-speed hardness in Damascene steel itself. This point would repay investigation, for if confirmed it would prove that, at any rate in certain cases, the use of alloy steels is unnecessary, and that they could be replaced by the cheaper carbon steels.

Obituary.

Dr. Julius Hann.

THE death of Hann, which was briefly noted in the issue of NATURE for October 13, removes from the meteorological world the most prominent figure of the past generation and the most productive of all contributors to that branch of science. Hann was born at Schloss Hans, near Linz, in Austria, on March 23, 1839, and his youth was spent in the Alps at Kirchdorf, in Kremstal, some thirty miles south of Linz. After taking his degree in mathematics and physics, he took up a professional career as teacher of those subjects in the high school of Schottenfeld, Vienna, and afterwards at Linz. At the age of twenty-nine he was appointed on the staff of the Central Anstalt für Meteorologie at Vienna, which was then under the direction of Carl Jelinek. He succeeded Jelinek as director in 1874, and continued in office until 1897, when, at the age of fifty-eight, he gave up the appointment and retired to Graz, in Styria, in order to pursue his studies in meteorology; but, finding Graz inconvenient for that purpose, he returned to Vienna in 1900, and thereafter, as professor in the university, he occupied a room in the Central Anstalt on the Hohe Warte, and continued to work there until the end of his life.

Hann's chief and most continuous occupation was the editing of the *Meteorologische Zeitschrift*, which, in conjunction with Jelinek, he started on May 1, 1866, as the *Zeitschrift der Oesterreichischen*

Gesellschaft für Meteorologie. From 1877 to 1885 he was sole editor of that journal, and when, in the latter year, it was combined with the *Zeitschrift der Deutschen Meteorologischen Gesellschaft,* under the title which it now bears, Prof. W. Köppen, of the Seewarte, Hamburg, became his collaborator, and in 1892 Dr. G. Hellmann, of Berlin. More recently Dr. R. Süring, of Potsdam, shared the editorial duties, and at the beginning of this year Felix Exner, the present director of the Central Anstalt, relieved Hann, whose strength was failing. From its beginning the *Zeitschrift* has been recognised as the leading meteorological journal of the world, and as indispensable for any library in which the science of meteorology is represented.

Hann was one of the secretaries of the original international assembly of meteorologists at Leipzig in 1872, a member of the International Meteorological Committee from 1878 to 1898, and president d'honneur of the international conference at Innsbruck in 1905.

He was not only an exemplary editor of the *Zeitschrift,* but also an indefatigable contributor. Every number contained articles from his pen. No subject of meteorological interest escaped his notice. He was instrumental in obtaining for the journal all the data for out-of-the-way places that he could hear about. He moved, for example, our Meteorological Council to publish the results of the observations at the stations of the Royal Engineers and Army Medical Department which had been established through the influence of General Sabine, and more recently he always searched the blue-books of our scattered Colonies for information that would otherwise have been practically inaccessible to meteorologists. The whole world was his parish, and he took great care of it.

By May 1, 1906, Hann had been editor of the *Zeitschrift* for forty years, and the epoch was marked by the publication of a special volume of contributions made by his friends, pupils, and colleagues. It is known as the "Hann Band." It was edited by Dr. Hellmann, of the Prussian Institute, his colleague as editor of the *Zeitschrift,* and Prof. J. M. Pernter, Hann's successor as director of the Central Anstalt in Vienna.

In the spring of 1919 Hann's eightieth birthday was celebrated, and the opportunity was again taken to mark appreciation of his services by the collection of a fund to be placed at the disposal of the Vienna Academy for the encouragement of the study to which he had so assiduously and successfully devoted his life. By that time the disastrous effects of the war upon the finances of Austria had become realised, and Hann, in common with many other Austrian men of science, suffered lamentable privations, under which his health suffered, though he maintained his industry and assiduity. He died in Vienna on October 1.

Hann was a most voluminous author. Vienna was a great centre for the study of Erd-kunde, and the school of meteorology and geophysics, which owed much of its inspiration to Hann, is probably without a parallel in the world. The recital of his work by the Royal Meteorological Society at the award of the Symons medal in 1904 refers to 121 titles in the Royal Society catalogue and the following comprehensive books: Astronomical geography, meteorology, and oceanography in "Allgemeine Erd-kunde," published in 1881 by himself conjointly with Profs. Hochstetter and Pokorny; in 1883, "Handbuch der Klimatologie," which has now reached three editions, and is recognised everywhere as the standard work on that subject; in 1887, "Atlas der Meteorologie," forming part 3 of Berghaus's "Physikalischer Atlas"; and, lastly, in 1901, the "Lehrbuch der Meteorologie," "the most thorough treatise in all branches of the science," an indispensable work of reference for all meteorologists, which also has now passed into its third edition.

The amount of information contained in these works is extraordinary, and the method of presenting it equally remarkable, so much so that Hann's name is a household word wherever meteorology is discussed, and his position as the leading meteorologist of the world is unchallenged. While everything passed under his notice as editor of the *Zeitschrift,* he had a genius for seeing the bearing and noting the scientific connection of the various contributions of authors writing from many points of view. It is to Hann perhaps more than to anyone else that we owe the advances which have been made in recent years from a heterogeneous collection of meteorological erections towards a meteorological edifice on ordered scientific lines.

It is not practicable, within the limits of this notice, to make any enumeration of his own contributions to the science; his books are the best guides. From the first, mountain observations were among his favourites, and from that point of view he was the first to discover that a cyclone is in reality a cold creature. His studies in climatology led him also from the first to insist on the need for precision in the evaluation of mean daily temperature, and in recent years he wrote important papers on the subject with reference especially to the temperatures of tropical countries.

Hann was, indeed, the chancellor of the realm of meteorology. "It is said that the chief notary or scribe of the Roman Emperor was called chancellor either because he was entrusted with the power of obliterating, *cancelling,* or crossing out such expressions . . . as seemed to him to be at variance with the laws or otherwise erroneous; or, more probably, because he sat *intra cancellos,* within the lattice-work or railings which were erected to protect the Emperor from the crowding of the people." As one reads this definition of what a chancellor was and did, we may well think of Hann, indefatigably occupied in the seclusion of his room in the Hohe Warte of the Imperial City of Vienna, protected from the crowding of

official duties, yet in continuous touch with the whole meteorological world, wasting no time over controversy, keen to appreciate the scientific laws and scrupulous impartially to place everything that complied therewith at the service of the whole scientific world.

Fully occupied in the enjoyment of his work, he was too busy for journeys that would separate him from it. Since 1898 he has not often been seen outside Vienna or his summer resort. He leaves a widow, a son, and two daughters to mourn his loss, which calls forth the assured sympathy of colleagues and friends in all parts of the world.

Hann received many distinctions. He was "Hofrat" in 1891, and subsequently was ennobled with the prefix "von"; but he made little display of the distinction. He had also the Ehrenzeichen für Kunst und Wissenschaft, and was a Knight of the Prussian Order "Pour le Mérite," a member of the Academy of Vienna, and honorary or foreign member of foreign academies and societies in all parts of the world. He was the recipient of the Buys Ballot medal, the Symons medal, and many other recognitions of his pre-eminent services. NAPIER SHAW.

BENJAMIN HARRISON.

THE late Benjamin Harrison was born on December 14, 1837, at Ightham, Kent, where his family had resided for several generations. Educated locally, he had the good fortune to be trained by two schoolmasters interested in science and archæology, and thus the natural trend of his mind was greatly stimulated. On leaving school at the age of fifteen he entered his father's shop, and after his father's death carried on the business of grocer until a few years ago. He passed peacefully away on October 1 after a few days' illness in the house in which he was born. He was married twice, his first wife dying in 1877, and his second wife (for many years an invalid) surviving him only a week. He leaves one son and two daughters.

In early life Harrison was a keen botanist and an enthusiastic collector of fossils and flint implements, and he soon got in touch with such well-known workers as the late Lord Avebury, F. C. J. Spurrell, and Roach Smith. In 1870 he met the late Sir Joseph Prestwich, who, perceiving the importance of his discoveries, encouraged him in many ways. As a result of Harrison's field work, Prestwich, in 1889, published his well-known paper on the Palæoliths of Ightham (Quart. Journ. Geol. Soc., vol. 45, pp. 270–294), followed in 1891 by the Darenth paper (*op. cit.*, vol. 47, pp. 120–160), and in 1892 by the paper on the plateau implements (Journ. Anthrop. Inst., vol. 21, pp. 246–262), Prestwich claiming for these rudely chipped flints a much greater antiquity than the Palæoliths. This was the beginning of the great "Eolithic" controversy which has not yet received its final solution, and it would appear as though there will always be two opinions respecting "Eoliths." Henceforward Harrison's spare time was spent in accumulating evidence in support of the "Eoliths" and in elucidating other prehistoric problems, whilst his house became a Mecca for all students.

Harrison's name will always be associated with "Eoliths," but it was his evidence that enabled Prestwich to establish the "hill group" of Palæoliths whilst the excavations carried on by Harrison at the rock shelters at Oldbury yielded many late Palæoliths which are now regarded as St. Acheul II. Harrison published but little, yet no one was more willing to assist others with his knowledge. An extremely well-read man, his ready wit, kindness of heart, and cheerful disposition endeared him to a large circle of friends, who now mourn the loss of "old Ben." In 1895 he was awarded the Lyell fund by the Geological Society, and in later life he was the recipient of a Civil List pension. Harrison was one of those humble workers for science who, in the face of great difficulties, rise superior to their surroundings by strength of character and industry, and leave an imperishable name behind.

Notes.

AT a meeting of the Optical Society held on Thursday, October 13, the resolution passed early in 1915 suspending certain members, subjects of countries then at war with Great Britain, was revoked.

THE Thomas Hawksley lecture of the Institution of Mechanical Engineers for the present year is to be delivered at the institution on Friday, November 4, at 6 o'clock, by Dr. H. S. Hele-Shaw, who will take as his subject "Power Transmission by Oil."

AT the opening of the annual meeting of the Société de Chimie industrielle on October 10 the Dumas medal of the society and an illuminated address were presented by M. Dior, Minister of Commerce, to Sir William J. Pope.

"EARLY Relations of Egypt, Babylonia, and Syria" is the subject of a lecture to be delivered by Mr. Percy E. Newberry on Thursday, October 27, at 8.30 p.m., at the rooms of the Royal Society, Burlington House. This lecture is the first of a series on Egypt to be arranged by the Egypt Exploration Society. Tickets and further details can be obtained from the Secretary, 13 Tavistock Square, W.C.1.

THE programme for the session 1921–22 of the Institute of Metals contains, in addition to announcements of general meetings of the institute, the first list of meetings of the newly-formed London Local Section. There are now in existence local sections in Birmingham, Sheffield, Glasgow, and London, and

monthly meetings have been arranged at which papers by well-known workers will be read. Membership of local sections is open free to all members of the institute. The council of the institute has sent out, with the annual programme, a pamphlet comprising a series of notes for the guidance of those preparing papers for publication in the Journal of the Institute of Metals. This action should result not only in a commendable uniformity in the form of papers, but may also secure economy in the costs of production of scientific communications—a result much to be desired.

In a thoughtful article in *The Scientific Monthly* for September (p. 214) Prof. Irving Fisher discusses impending problems in eugenics resulting from war, hygiene, birth-control, and immigration. He concludes that his surveys "seem to indicate that much of what we call progress is an illusion, and that really we are slipping backwards while we seem to be moving forwards. Human ambitions under the opportunities afforded by civilisation seem to sacrifice the race to the individual. We congregate in great cities and pile up great wealth, but are conquered by our very luxury. We seek imperial power and not only damage, but destroy, our germ plasm in war. We seek social status and education, but limit motherhood. Like moths attracted by a candle, we fly towards the glamour of wealth and power and destroy ourselves in the act."

A timely and very necessary protest against the restrictions imposed upon the collection of birds and their eggs for scientific study in certain States in California appears in *California Fish and Game* (vol. 7, No. 3). It is pointed out that there "are about one hundred and fifty scientific collectors in California, as contrasted with more than one hundred and eighty thousand 'hunters,'" or, as we should say, "sportsmen." "Since practically all useful information regarding wild birds and animals," it is remarked, "is a result of the acquisition of specimens, the necessity for work of this kind is evident. The curtailment of scientific collecting must result in decreased scientific information. Furthermore, there is a danger of decreasing the number of ornithologists by cutting off the opportunity for the right kind of study. Our best ornithologists owe their early interest and their development largely to the unrestricted chance for securing specimens." We heartily endorse this protest.

Messrs. E. A. Hooton and C. C. Willoughby, in the Papers of the Peabody Museum of American Archæology and Ethnology, Harvard University (vol. 8, No. 1), report the results of the excavation of an Indian village site and cemetery near Madisonville, Ohio. The occupation of this site covered the interval immediately preceding the first intercourse of the Indians of this region with Europeans, and extended into the proto-historic period, during which the inhabitants were able to procure a small amount of European metals and glass beads, either from early missionaries or travellers, or indirectly through their Indian neighbours. This culture in prehistoric times extended over a considerable portion of southern Ohio, and there appears to have been a migration of these Indians, driven south by the Iroquois, into the region of the Ohio River. Unfortunately there is little osteological material available from the States of Indiana and Kentucky for comparison with that of Madisonville, and the skeletal remains from the graves of the great earthwork builders of Ohio, now in the museum, have not been as yet systematically studied.

In the *Fortnightly Review* for October Mr. Julian S. Huxley makes some suggestive observations on the evidences of variation and evolution as they occur in nature, derived from his study of the bird life of Spitsbergen during a visit to that island as a member of the Oxford University Expedition. The ringed or bridled guillemot is a simple Mendelian mutant of the common guillemot, differing only in the presence of a line of white encircling the eye and prolonged backwards across the side of the head. The two varieties live together and interbreed. The process of differentiation has progressed further in the Spitsbergen puffin and Mandt's guillemot, which are distinct northern geographical races of the common puffin and black guillemot, characterised by their larger size and paler colour. In the Spitsbergen geese, skuas, and eiders are found closely related species inhabiting the same region, but adapted to different modes of life. They are distinct in habit as well as in structure; the barnacle goose nests on the cliffs, the Brent goose on the low islands; Buffon's skua appears to keep more to the hills than Richardson's skua, while the king eider has been found nesting only singly on the tundra, not, like the common eider, in multitudes on islets.

An excellent summary of our knowledge of the "bacteriophage" is given by d'Herelle, its discoverer, in *La Nature* of October 1, p. 279. The fundamental observation on this subject is as follows: a patient suffering from the bacillary form of dysentery is observed for, say, thirty days. Every day a sample of the fæces is mixed with broth, filtered through a porcelain filter to remove the bacteria present, and the series of filtrates is kept. At the end of the thirty days, thirty broth cultures of *B. dysenteriae* are prepared, and then to each culture tube one drop of a fæces filtrate is added, and the tubes are incubated. After twelve hours the following kind of result is obtained: tubes 1 to 6, unchanged; tubes 7 to 18, entirely clear and free from turbidity; tubes 19 to 30, unchanged. In the clear tubes the dysentery bacilli will be found to have dissolved, hence the disappearance of turbidity. D'Herelle maintains that the agent which causes the solution of the dysentery bacilli is an ultra-microscopic organism, to which he gives the name "bacteriophage," and which he supposes is of importance in cure and in immunity. Others believe that the agent is a catalyst which causes micro-organisms to produce autolytic ferments.

IN *Natural History* (vol. 21, No. 3), Mr. F. Morton Jones gives a most interesting account of the influence of insect-trapping plants on their insect associates, with special reference to those species of the moth Exyra which pass their entire life-cycle in intimate contact with pitcher plants of the genus Sarracenia. There are three species of Exyra, two of which are confined each to a single species of Sarracenia, and a third species, more adaptable than the other two, which seems equally at home in five other species of pitcher plant. Mr. Jones considers the plant–insect relation stage by stage in the life-cycle of the insects. He points out first those adjustments common to them all which relate to the general plan of the insect trap of Sarracenia, indicating an association ante-dating the splitting of the insect group, if not the plant group, into its several species. He then indicates the further adjustments which each species of moth shows to its own species of food plant, suggesting that the process of adjustment has continued, either coincident with the development of the plant species or at least following the insect's association with the plant. He concludes that the peculiar characters of the plant have been a significant factor in determining the course of evolution of the insects, and demonstrates the stages by which the latter have become adapted to their uniquely dangerous habitat.

WRITING in the August number of the *South African Journal of Industries* on "Science in the Service of the State," Mr. T. G. Trevor complains that the government of nations is still in the hands of the "predatory" class, although the civilisation of to-day depends in every detail of its existence on science and the labours of the "creative" class. He attributes the unfavourable position of the scientific and technical classes in the South African civil service to this fact. Scientific workers in the Union's civil service are pilloried indiscriminately with the clerical and administrative classes when the Parliamentary estimates are under discussion, yet since Lord Milner inaugurated the scientific departments of the Union Government service, "locusts have disappeared, malaria is a thing of the past, whole districts which were formerly regarded as impossible for white population are now fully peopled." The work on irrigation and cattle diseases has transformed vast areas. What is more important still, these services rendered "are infinitesimal compared to what they might be if it were once appreciated by the country at large what scientific work really is." The country should regard the expenses of those civil servants who are engaged in research and productive work as an investment. Instead, the Government offers a much lower salary to a chemist than the Rand Club offers to its billiard markers. Mr. Trevor outlines the administrative scheme under which the Union's men of science suffer. He is under the impression that things are vastly different in this country; there he is mistaken. Salaries are probably on a better level, but Mr. Trevor's criticism of the attitude towards science, the ignorance of the Parliamentarian, the contempt of the administrator, and the indifference of the average citizen, can be applied with equal appositeness to the condition of affairs here.

THE *Kew Bulletin* (No. 6, 1921) contains an account of a visit to the Cameroons and Nigeria by Dr. A. W. Hill, assistant director of the Royal Botanic Gardens, undertaken at the request of Sir Hugh Clifford, Governor of Nigeria. The main object of the visit was to report upon the Botanic Gardens at Victoria, Cameroons, which have suffered from some neglect during and since the war. A description of the gardens and associated buildings is given, and Dr. Hill strongly recommends their restoration to a state of proper order and efficiency. A large area of the British sphere of the Cameroons, from sea-level to about 1800ft., is occupied by large plantations, where cocoa, rubber, kola, oil palm, and bananas are extensively cultivated. The writer emphasises the need for a department of plant pathology at the Victoria Gardens for the investigation of the problems in relation to plant-diseases, selection, breeding, and the soil, which will arise on these extensive plantations. In addition to research, instruction should also be an important function of the garden. In Nigeria somewhat different conditions prevail; the soil is generally less fertile, and the cultivated plots are in native hands, and relatively small. Dr. Hill insists on the need for appointing agricultural chemists to study the principles of the native practices of cultivation, and to develop and improve any that are found to be of value. Economic botanists are also needed to investigate the native economic products and demonstrate their value for the good of the community. A brief visit was made to the Bauchi Plateau, a dry granitic area in Northern Nigeria, the botany of which had not previously been studied, and proved to be of considerable interest.

IN a pamphlet published by the Institution of Water Engineers, Mr. T. Sheppard collects the published facts relating to Spurn Point and the lost towns of the Humber coast. As regards Spurn Point, plans, and in recent times, measurements, give accurate data as to the growth of the land. This has been so rapid that from the seventeenth century onward the lighthouse at the point has been continually moved westward. Thus between 1766 and 1771 the point is said to have grown 280 yards in length, although during the next century its growth was slower, and barely exceeded the same amount. The point is still extending in length and width, but if the growth continues a break will occur somewhere in this narrow spit of land. This has probably occurred in the past, since more than one old chart shows an island where the peninsula now is. The lost town of Ravenser, the site of which is uncertain, possibly existed on such an island. Founded by the Danes in the ninth century, Ravenser became in time a flourishing and wealthy port, but during the sixteenth century it was entirely swept away. The last reference to the place is said to have been in Leland's "Itinerary." Mr. Sheppard goes at length

into the story of this and other towns that have now vanished from the south and east coasts of Holderness.

THE Jahrbuch des Norwegischen Meteorologischen Instituts for 1920 has been issued. As usual, it gives detailed data from Aas and Kristiania, a summary of the daily data from twelve important stations, and monthly means for some 70 stations. The volume also contains data from the Norwegian meteorological station at Green Harbour, Spitsbergen, including monthly means for 1919, and the daily records from July, 1919, to June, 1920. The Norwegian rainfall statistics for 1920 are published in "Nedböriaktagelser i Norge," and include data from 485 stations. A large-scale rainfall map of Norway is included.

SOME notes on the "rollers" of Ascension and St. Helena are given on the Meteorological Chart of the East Indian Seas for November. As is well known, the leeward shores of these islands frequently experience a heavy swell from the north-west, which, setting in without any warning, produces a heavy surf. At other times, but less frequently, the swell is from the south-west. During the continuance of these rollers, which are heaviest during January and February, landing is difficult and hazardous. Records for St. Helena show that rollers prevail on about twenty-five days, and heavy swell on rather more than twice as many days in the year. The cause of this phenomenon is not thoroughly understood, but it is supposed to be due to distant gales of wind, either in the North or South Atlantic, blowing in the direction of the islands. This explanation appears to suit the facts, but further investigations are required. It is probable that the heavy swell on the Gold Coast has a similar origin.

COL. SIR S. G. BURRARD's discussions of gravity anomalies in northern India and of the relation of the Himalayas to the Gangetic trough have been quoted in NATURE (vol. 97, p. 391, 1916, and vol. 103, p. 351, 1919). His review of the evidence in favour of the theory of isostasy appeared in the Journal of the Royal Geographical Society for July, 1920. In 1917 Mr. R. D. Oldham published his important memoir on "The Structure of the Himalayas and the Gangetic Plain" (Mem. Geol. Surv. India, vol. 42, pt. 2), in which he laid stress on the mass of comparatively light sediment in the great trough stretching southward from the mountains. Lt.-Col. H. McC. Cowie (Survey of India, Prof. Paper 18, 1921) now puts forward "A Criticism of Mr. R. D. Oldham's Memoir," in which he reviews the whole series of gravity anomalies in the region as at present known, and concludes that a deficiency of mass, widespread throughout the Gangetic area, is insufficient to explain the "very rapid fall, in a northerly sense, in the value of the residual between Dehra Dūn and Kaliana, Birond and Bansgopal, Siliguri and Jalpaiguri." The observed pendulum deflections at these and a number of other stations, and those deduced by taking into consideration a Gangetic trough in addition to surface masses, are given in Table VIII. Two series of residuals are obtained by subtracting from the observed deflections, first, the calculated deflections produced by the surface-features and their compensation, and, secondly, these deflections as modified by a trough of the dimensions given by Mr. Oldham. Lt.-Col. Cowie finds so little difference between the resulting quantities that the characteristic anomaly on the Himalayan edge remains for him a problem awaiting solution. The large contoured map on the scale of 1 : 3,000,000 accompanying his paper includes the whole "Himalayan-Tibetan mass," and has many obvious uses. Kaliana is given on it as Kallāna.

THE October issue of the *Philosophical Magazine* contains a paper on "Escapements and Quanta," which Sir Joseph Larmor communicated to the British Association at Edinburgh, and in which he suggests that the atom may be analogous to a clock. The outer electron system of the atom, on which its chemical and spectroscopic properties depend, and which has certain definite rates of oscillation, would correspond to the pendulum, or better, to a compound pendular system of a clock, and the inner core of the atom to the spring which, by means of the escapement, slowly imparts its energy to the pendulum in quanta fashion. Dynamical systems of this type are worth introducing into our theories of atomic constitution, and will, Sir Joseph thinks, well repay investigation.

THE Société Genevoise d'Instruments de Physique send us an account of their new "universal microscope for mineralogical researches," intended for research work on the optical characters of microscopic crystals in thin sections of rocks. It can be arranged either so as to have the objective rigidly attached to the rotating stage in the manner devised by Nachet, or with the objective stationary while the stage rotates, and the Fedorov or theodolite stage can then be employed. There is apparently no mechanism for the simultaneous rotation of the Nicols. The stage can be lowered for use with objectives of long focal length—a circumstance which will be very useful in many cases. Another unusual feature is the use of adjustable adapters which remain fixed to the objectives. By means of these the small differences of centring between different objectives may be eliminated. A similar arrangement has been employed in this country.

THE concluding remarks of the chairman, Mr. P. Raghavendra Rao, of the Board of Scientific Advice—to use its new name—at the Mysore Economic Conference held at Bangalore in June, dealt with the activities of the Board during the preceding year. The Government has been approached with the view of inducing it to instal plant for the production of sulphuric acid at the Bhadravati Iron Works. It is pointed out that as charcoal is the chief fuel used, it would be of considerable economic advantage if the grey acetate of lime, which is obtained from the acetic acid formed during production of charcoal, could be converted into glacial acetic acid on the spot. The Board has also considered the question of the manufacture of tannin

extracts and of lac, as well as matters relating to the development of the sugar industry. Arrangements have been made by which one or two Indian students can receive a training in the scientific manufacture of sugar under the Imperial Department of Agriculture, Barbados, West Indies, and it is stated that the course is open to a student of chemistry or any other who is prepared to consider it.

A NOTE of the meeting at Bergen of the International Commission for the scientific investigation of the upper air, is given in the *Meteorological Magazine* for September. The meeting commenced on July 26, and was continued on the following days. The preceding (seventh) meeting of this Commission was held in Vienna in 1912, though at that meeting the time was mainly occupied with business questions, little time being given to scientific discussion. At the Bergen meeting, this year, the leading place was given to scientific contributions from the members of the Commission and other meteorologists interested in the work. Much attention was directed to further developments in the study of the Polar Front. Broadly speaking, the Scandinavian school finds that depressions occur in families of four, each following a track slightly further south than its predecessor, the first and third of the family being generally more intense than the second and fourth. The note mentions that on the average a new family begins every $6\frac{1}{4}$ days. The Commission decided that an international publication of the results of the investigation of the upper air on certain selected days should be continued, and a table is given showing the dates when the ascents are to be made. A report of the proceedings of the meeting has been published, and was presented to the International Meteorological Committee recently held in London.

AT the autumn meeting of the Iron and Steel Institute recently held in Paris a paper was contributed by M. L. Guillet on "The Position of the Metallurgical Industries of Northern and Eastern France: Their Destruction and Reconstruction." M. Guillet himself writes with first-hand knowledge of this subject, and emphasises that of the total destruction only a very small proportion was due to actual war damage; the bulk of it was deliberate, and had as its object the putting of French iron and steel works out of action for many years to come. He states that in some regions the work of demolition was carried out so systematically that a whole arsenal of works-breaking machinery was created for the purpose. He himself removed at the Biache Saint-Vaast Copper Works, near Arras, a whole series of high-explosive cartridges from the principal parts of the plant and machinery. The work of reconstruction has been truly remarkable considering the conditions under which it had to be undertaken. After the armistice it was impossible to rely on finding anything which might be needed in the immediate locality. Machinery, raw materials, and labour were lacking, and the workmen were scattered far and wide. A lack of coal and means of transport made it impossible to rely upon regions still intact. Details are given of how this situation was met in a number of the most important metallurgical districts and of the results accomplished. Despite the above handicaps and financial difficulties arising out of the incomplete Peace Treaty, the works are little by little resuming their activities. Moreover, in the course of their reconstruction they have been completely modernised, and it is probable, therefore, that their efficiency will be considerably increased. M. Guillet regards the outlook as both prosperous and promising.

AMONG the forthcoming books included in the announcement of the Cambridge University Press in NATURE of September 22, p. 131, was one by Major P. A. MacMahon, "New Mathematical Problems," the title of which, we are now informed, should have been given as "New Mathematical *Pastimes*." The book contains a series of puzzles based on the permutations and combinations of elementary geometrical shapes, and is a contribution to the literature of mathematical recreations.

"OCEAN Research and the Great Fisheries," by G. C. L. Howell, is announced by the Oxford University Press as almost ready. The author writes about the organisation of ocean research, statistics, the apparent effect of the war on fish supplies, fish culture, etc., and discusses the problems connected with a dozen of the most important kinds of fish, dealing with the varieties separately.

"THE Dictionary of Applied Physics," which Messrs. Macmillan and Co., Ltd., propose to issue under the editorship of Sir Richard Glazebrook, is now in an advanced stage of preparation. The work will appear in five volumes of 600–700 pages each, the subjects of which are as follows:—(1) Mechanics, Engineering, and Heat; (2) Electricity; (3) Metrology, Meteorology, and Measuring Appliances; (4) Metallurgy and Aeronautics; and (5) Optics, Sound, and Radiology. It is hoped that vol. 1 will be ready for publication early in 1922, and it will contain important articles by a number of distinguished contributors. Sir Alfred Ewing has written on thermodynamics, the liquification of gases, and refrigeration, Sir Charles Parsons and Prof. Stoney on the steam turbine, Sir Dugald Clerk and Mr. Burls on the internal-combustion engine, Prof. Dalby on the balancing of engines, and Dr. E. H. Griffiths on the mechanical equivalent; while Dr. Horace Lamb has provided several articles on related mathematical questions. Other topics dealt with are friction, lubrication, ship resistance, manometers, the determination of the elastic constants of materials, dynamometers, the theory of elasticity and its application to structures, hydraulics, and the kinematics of machinery. In the heat section Dr. Coblentz has written on the experimental verification of the laws of radiation, Mr. C. G. Darwin on radiation theory and the quantum, Mr. W. C. D. Whetham on the phase rule, Mr. Ezer Griffiths on calorimetry and pyrometry, and Prof. Porter on thermal expansion. The editor has thus secured the services of a recognised authority on each of the subjects dealt with, and this plan has also been adopted in the remaining volumes which the publishers hope to issue at short intervals after the appearance of the first.

Our Astronomical Column.

THE LUNAR ECLIPSE OF OCTOBER 16.—The three interesting phenomena of the present year—the solar and lunar eclipses and the occultation of Venus—have all been favoured with fine weather in London. The chief interest of the lunar eclipse on October 16 was the varied colouring of the shadow. The outer portion was bluish- or slate-grey, the inner portion decidedly ruddy. It is not difficult to give an explanation; the light reaching the outer portion needed only a small amount of refraction, and passed through the higher regions of the earth's atmosphere, suffering but little absorption, while that near the centre of the shadow underwent large refraction, and must have passed close to the earth's surface, so that only the long red waves could get through. Some have reckoned this as a dark eclipse; the present writer would class it as of average character, having seen both darker and brighter eclipses. There was a large amount of lunar detail plainly visible in the outer region of the shadow; a Greenwich photograph with 40 seconds' exposure showed the Maria and bright rays conspicuously. Two of the predicted occultations were successfully observed at Greenwich. The sky near the moon was too bright to permit the others to be seen.

REFORM OF THE CALENDAR.—The Astronomical Union will meet next year in Rome, and among the committee meetings that will be held there is one on calendar reform. This committee is presided over by Cardinal Mercier, and includes Sir F. W. Dyson and Prof. Sampson from Great Britain, MM. Bigourdan and Deslandres from France, M. Lecointe from Belgium, and Prof. Campbell from the United States. The main outlines of the reforms to be discussed include a more uniform arrangement of the lengths of the months, alteration in the position of the leap day (the end of the year would be far more convenient from the point of view of astronomical tables), and making the incidence of the week-days the same every year by placing one day a year (two in leap year) outside the weekly reckoning. The further question of the fixation of Easter may be raised, but the committee will, of course, not attempt to make any change without seeking ecclesiastical co-operation. The question of calendar reform has been mooted for many years, but it is much easier to recognise the inconveniences of the present system than to agree on an alternative one.

THE SPECTRUM OF ϕ CASSIOPELÆ.—Major W. J. S. Lockyer and Mr. D. L. Edwards contribute a paper on this spectrum to the June Monthly Notices. They show that it is intermediate between those of α Cygni and γ Cygni. Thus the hydrogen lines and the enhanced lines of manganese and iron progressively weaken from α to γ, while the remaining iron lines and the enhanced lines of titanium progressively strengthen. Seven stars are indicated with spectra almost exact replicas of that of ϕ Cassiopeiæ, including Canopus and α Leporis. Eight other stars are indicated with spectra intermediate between those of ϕ Cassiopeiæ and γ Cygni; they include the two Cepheid variables, η Aquilæ and δ Cephei; it is further stated that the spectra of these two approach that of ϕ Cassiopeiæ at maximum, and that of γ Cygni at minimum. Reasons are given for inferring that all the stars discussed are giants, with temperatures highest in the α Cygni type and lowest in that of γ Cygni.

The paper also discusses the differences between the spectra of giant and dwarf stars of spectral type F, Procyon being taken as a representative of the dwarfs. The hydrogen lines are much sharper in the giant stars, and the enhanced metallic lines more pronounced.

Reproductions are given of five of the spectra discussed, and it is also pointed out that the research has some importance in connection with the interpretation of the spectra of novæ, the earlier stages of which resemble the α Cygni type.

MINOR PLANETS.—*Astr. Nach.*, No. 5122, contains an important research by Edzard Noteboom on the perturbations of Eros, in continuation of work on the subject by Prof. Witt, the discoverer of Eros. The actions of Mercury, Uranus, and Neptune, though almost insensible, are included for completeness. The observations of eleven oppositions, from 1893 to 1914, are compared with theory and twenty-four normal places formed. After correcting the earth's mass, the comparison shows that the largest discordance is 4″, most of them being under 2″. The research was undertaken mainly to investigate the large terms produced by the earth, and thus obtain a correction to its mass. The combined mass of the earth and moon was found to be $1/(328370 \pm 102)$, leading to a solar parallax of 8·799″.

It is important that Eros should be well observed at every opposition. Only two observations were available in 1903. It is still of magnitude 11½, and a continuation of Mr. Seagrave's ephemeris for Greenwich midnight is given:—

	R.A. h. m. s.	N. Decl. ° ′		R.A. h. m. s.	N. Decl. ° ′
Oct. 19	22 1 8	10 45	Nov. 4	22 4 26	9 30
23	22 0 38	10 22	8	22 7 21	9 20
27	22 1 1	10 2	12	22 10 59	9 13
31	22 2 20	9 45	16	22 15 19	9 10

The same issue of *Astr. Nach.* contains an investigation of the orbit of the planet 887 Alinda. It was discovered four years ago by Prof. Wolf, and approaches closely to the earth's orbit in perihelion, but has large eccentricity; as its period of four years is about one-third of Jupiter's period, the perturbations by that planet will be large. They have been investigated by Mr. K. Schütte, who gives a search ephemeris for the present return. The recovery of the planet is desirable, but as the magnitude is 13·3 and the declination south, it is useless to give the ephemeris here.

THE CENTENARY OF "ASTRONOMISCHE NACHRICHTEN."—*Astronomische Nachrichten*, founded in 1821 by Schumacher with the encouragement of Gauss, has celebrated its centenary by the publication of a remarkable "Jubiläumsnummer," which contains articles by astronomers in all the continents, who join in expressing appreciation of the valuable work that this publication has done for astronomy. It has from the beginning exhibited a cosmopolitan spirit, aiming at the general and rapid diffusion of important information, and giving a large portion of its space to articles from other countries than its own. As Mr. R. T. A. Innes says in a cordial message: "Continuity has been maintained; the *Astronomische Nachrichten* is in 1921 what it was in 1821, the astronomer's newspaper, its columns ever open for astronomical news from any part of the world."

One of its features has been the absence of fixed days of publication, all important communications being published with the smallest possible delay. It has, however, conformed almost exactly to an average weekly interval. The periodical has been invaluable to workers in the special lines of comet and minor planet observation, and the advance of knowledge in these branches is largely due to its aid.

The following is a list of the principal contents of

the "jubilee number." O. Bergstrand writes on the effective wave-lengths of the galactic stars; A. S. Eddington on the dynamical equilibrium of the stellar system; P. Guthnick and A. A. Nijland on the Cepheid problem; J. G. Hagen on dark nebulæ; H. Shapley on the galactic distribution of the B stars; and H. v. Zeipel on the masses of stars in clusters. The list is not exhaustive, but will serve to give an idea of the varied contents of this memorable publication.

Geology of the South Wales Coalfield.[1]

AS is pointed out by the Director in the preface to the memoir under notice, the district, though not containing many deposits of economic importance, includes a very extensive series of rocks, ranging from the Ordovician to the New Red, and the hope is expressed that the district will be recognised as a typical area for the study of the formations represented, as developed in S.W. Wales.

The area shows considerable physical diversity. The highest ground is formed by remnants of a plateau mainly consisting of Lower Old Red Sandstone. The remnants are separated from one another by erosion-valleys and by level tracts chiefly composed of Carboniferous Limestone. The latter are referred to as the limestone flats, and considered to be probably the work of the Pliocene sea. The remarkably level character of these flats is shown in the frontispiece. The coast is deeply indented by partly drowned valleys (rias), of which the chief is Milford Haven. Many of the valleys are independent of the geological structure, and afford examples of superimposed drainage.

The oldest rocks occurring in the district are shales and sandstones belonging to the Llanvirn series exposed in the anticlines of Freshwater East and Castlemartin Corse. Here, too, are seen Silurian rocks, which both lithologically and in fossil-contents are of the Welsh-borderland type.

The Old Red Sandstone is specially interesting from the intercalation in the upper beds of bands containing a marine Devonian fauna. These bands, which were originally noted by de la Beche, and afterwards referred to by Salter, have yielded more than fifty species of fossils, by far the greater number coming from Freshwater West. The author considers that apart from these marine intercalations in the highest beds, the Old Red Sandstone represents an aqueous deposit formed under "continental" conditions. He does not believe that any of the rocks are directly æolian, the sandstones being too well bedded and conglomeratic to represent sand-dunes, and though the marls may be formed of wind-borne dust, it probably settled in water.

The Old Red Limestones "probably represent precipitates thrown down as the fresh, tributary waters carrying the calcium carbonate in solution mingled with the more saline water of the basin of deposition." The breccias and conglomerates of the Upper Old Red contain much igneous material, chiefly acid lavas, which, Dr. H. H. Thomas points out, "show a general resemblance to the pre-Cambrian and lowest Palæozoic rocks of Pembrokeshire, more particularly of the part north of St. Bride's Bay." In the Ridgeway conglomerate of the Lower Old Red Sandstone the pebbles are chiefly quartzite, igneous material being almost unrepresented.

The Carboniferous Limestone Series (Avonian) is perhaps the most interesting formation in the area, and the full account now available will be most acceptable to all students of these rocks. The author, like all other workers on the Carboniferous Limestone, has been deeply influenced by the work of the late Dr. Vaughan, to whom he "cannot adequately express his indebtedness." The faunal subdivisions recognised are in the main those of Vaughan's original paper, but the author draws the line between the Upper and Lower Avonian at the top of the C_1 beds, where a marked transgression occurs in the northern part of the South Wales area, instead of at the top of C_2, where Vaughan originally drew it.

The study of the rock-types of the Carboniferous Limestone Series is one which the author has made peculiarly his own, but he has already treated the subject so fully in describing the rocks of Gower that there is comparatively little of a novel character in the present memoir. A description is given of the interesting reef dolomites, and of the characters which lead the author to compare them with the reef or knoll limestones of Clitheroe and the Belgian Waulsortian. They occur in the C beds of the extreme south-west corner of the district, and appear to be essentially bryozoan reefs. Oolites have been recognised at an exceptionally large number of levels in the Lower Avonian. In very numerous respects mentioned by the author the rock-types are identical with those of the Bristol district. The term "Zaphrentid-phase," which was introduced by Vaughan, but not defined, is employed by the author, who defines his use of the term. A very lengthy fossil list is included.

The "Millstone Grit"—the term used to include the sandstones and shales intervening between the Carboniferous Limestone and the Coal Measures—though well exposed, is greatly disturbed, and the strata are difficult to correlate. The lower beds are shown to contain radiolarian chert and fossils of Pendleside type, while the presence of certain plants in the upper beds appears to indicate an horizon as high as the Middle Coal Measures of the Midlands.

Certain deposits of a peculiar character preserved in fissures or cavities of the Carboniferous Limestone are the only ones referred to the New Red (Trias). The most remarkable of these are the gash-breccias, which are fully described, and illustrated by an admirable plate. The author considers that they are probably due to the collapse of the roof and sides of cavities formed by the underground solution of the limestone.

A particularly full and interesting account is given of the earth-movements which have affected the district, and while by far the most important are the post-Carboniferous (Armorican) movements, others occurred between the Llanvirn and Wenlock periods, between the Ludlow and the Lower Old Red Sandstone, between the Upper and Lower Old Red Sandstone, between the Upper and Lower Avonian, and between the Carboniferous Limestone and Millstone Grit. All the chief strike-faults are overthrusts of Armorican date, while the cross-faults, which are tabulated, also appear to belong in the main to the same period of disturbance.

The district differs from Gower and some other parts of South Wales in that glacial deposits are nowhere seen resting in clear sequence on undoubted raised-beach.

The memoir is illustrated by five fine plates and an admirable series of sketch-maps. It everywhere bears evidence of the minute observation and thoroughness which are so characteristic of the author's work.

[1] Memoirs of the Geological Survey: England and Wales. "The Geology of the South Wales Coalfield." Part 13: "The Country around Pembroke and Tenby." By E. E. L. Dixon. (Southampton: Ordnance Survey Office; London: E. Stanford, Ltd., 1921.) 8s. net.

National Institute of Agricultural Botany.

THE King and Queen paid an informal visit to the headquarters of the National Institute of Agricultural Botany at Cambridge on Friday, October 14. They were accompanied by Princess Mary, and the suite included the Minister of Agriculture, Sir Arthur Griffith-Boscawen. Their Majesties were received at the institute by Sir Lawrence Weaver, chairman of the institute, and Lady Weaver and Mrs. Brinton, chairman and founder of the Housing Association for Officers' Families, by which the fourteen houses adjoining the institute have been built for the accommodation of officers' widows and disabled officers. After the presentation of a number of visitors and members of the council of the institute, the Royal party were conducted round the buildings by Sir Lawrence and Lady Weaver and the director of the institute, Mr. Wilfred H. Parker. They were shown an exhibit of wheats and barleys by Prof. Biffen and Mr. E. S. Beaven, the different processes of seed-testing by Mr. C. B. Saunders, chief officer of the Official Seed Testing Station, and a collection of potatoes arranged by Dr. Salaman and Mr. H. Bryan, the superintendent of the Potato Testing Station, Ormskirk. The Royal party were then conducted to the council room, where they made the first entries in the visitors' book, and, after the King had planted a mulberry tree in front of the institute to commemorate his visit, inspected the domestic quarters. Mrs. Brinton then took their Majesties to visit the houses occupied by officers' widows, in front of which a second mulberry tree was planted by the Queen.

FIG. 1.—National Institute of Agricultural Botany, Cambridge.

The necessity for such an organisation as the institute became very apparent during the latter years of the war, when the imperative need for an increase of food production led the Government to introduce a measure of seed control. This resulted in the establishment, in the autumn of 1917, of the English Official Seed Testing Station, and it was from the study of Continental methods of seed control that the National Institute of Agricultural Botany came to be founded in the early part of 1919 by Sir Lawrence Weaver, now the Second Secretary of the Ministry of Agriculture and Fisheries, who has been responsible for the administration of the new control of seeds. The institute has been modelled generally on the lines of the famous Svalof organisation in South Sweden.

The institute was constituted as a charitable trust. Large contributions to the trust fund were received from Sir Robert McAlpine and Sons, Viscount Elveden, members of the agricultural seed trade of the United Kingdom, the milling industry, and other agricultural trades, while a generous gift of a 334-acre farm at St. Ives, Huntingdon, was made by Mr. Fred Hiam, of Cambridge. The national importance of the scheme was recognised by the Development Commissioners, who have provided a grant on the *1l.* for *1l.* basis.

The director of the institute, Mr. W. H. Parker, was appointed in April, 1920. Prof. R. H. Biffen, the director of the Plant Breeding Institute at Cambridge University, is one of the vice-presidents of the institute, and works in the closest co-operation with it.

The institute's headquarters buildings have only recently been completed, and were formally opened by Sir Lawrence Weaver on Friday, October 7. They are situated in Huntingdon Road, Cambridge, about 1½ miles from the town, and were designed by Mr. P. Morley Horder. The thirty acres surrounding the buildings will be utilised as a trial ground. In addition to this, the institute owns the Hiam Farm, St. Ives, Huntingdonshire, referred to above, and a farmhouse and 39 acres of good market land at Ormskirk, Lancashire, which are used as the Potato Testing Station.

The work of the institute is divided into three main branches:—

(*a*) *The Crop Improvement Branch.*—The improvement of farm crops will be achieved by the testing of promising new and re-selected varieties of all kinds of plants of the farm which may be handed to the institute by the Plant Breeding Institute of Cambridge University, other similar organisations, and individual plant-breeders, the multiplication of those stocks which have shown the best results as to yield and quality, and the subsequent marketing through existing trade channels of those varieties which, after further close observation, are approved by the institute. The growing-on of the new varieties to a commercial scale will be undertaken at the Hiam Farm, St. Ives, and also by contract with farmers in different parts of the country.

(*b*) *The Official Seed Testing Station for England and Wales.*—The administration of the English Official Seed Testing Station has been delegated to the institute by the Ministry of Agriculture. The greater part of the headquarters buildings at Cambridge is now occupied by the Seed Testing Station, which had hitherto—since its formation—been inadequately housed in temporary premises in London. The station is now the largest and best-planned in the world.

(*c*) *The Potato Testing Station.*—The institute carries out at its Ormskirk station the highly important potato immunity trials, which establish the immunity or otherwise of different varieties of potatoes from the great scourge of wart disease. This work is delegated to it by the Ministry of Agriculture, but the institute also holds trials to establish the time of maturity, yield, and quality of potatoes.

Synonymity in potato varieties has long been a

source of loss and confusion to potato producers and merchants. The synonym committee of the institute, consisting of experts both scientific and practical, makes an annual report which declares which of the varieties entered for the immunity trials under new and distinct names prove to be identical with varieties already in the market.

During their visit the King and Queen were able to see the normal work of the Official Seed Testing Station at progress in most of the laboratories. The exhibits of cereals and potatoes arranged in two of the laboratories enabled the visitors to realise the scope of the other branches of the institute's work. Their Majesties were keenly interested in everything that was shown to them, inquiring minutely into the processes of seed-testing, and paying special attention to the methods of potato-breeding and the measures taken to check the spread of wart disease. At the close of their visit they expressed to Sir Lawrence Weaver their complete satisfaction with all that they had seen and their admiration of Mr. Horder's planning of the buildings and the arrangements made to secure the efficiency and comfort of the staff.

Chemical Reactivity and the Quantum Theory.

By Dr. Eric K. Rideal.

THE recent discussion held by the Faraday Society on modern developments in the theories of catalytic chemistry gave rise to an important debate concerning what has been termed the radiation theory of chemical action. It is now almost generally accepted, both by the protagonists and by some of the opponents of this theory, that molecules of the same species in a reacting system may differ from one another in what is termed chemical "activity." Thus in a mixture of hydrogen and oxygen a certain fraction, both of the hydrogen and of the oxygen molecules, are "active." Collision between active molecules of the two species results in chemical combination; collision between inactive molecules produces no chemical change.

It is further argued by the supporters of the theory that true monomolecular chemical reactions exist, *e.g.* the conversion of allotropes, the dissociation of a diatomic gas, or the decomposition of substances like phosphine or ammonia; consequently, as pointed out by Perrin, "active" molecules must exist *per se*, and reaction is not the result of a particular kind of directive collision, or, indeed, of a collision taking place at some particular phase of the molecular vibration; the decomposition of phosphine thus finds an analogy in the disruption of radium.

Granting that this assumption is correct, attention has to be directed to the source of energy of activation. The opponents of the theory, who go as far as to admit the validity of the first postulate, affirm that this energy resides within the molecule itself, and may possibly be identified with the "null punkt" energy at absolute zero.

The supporters of the radiation theory adopt the hypothesis that the energy of activation is acquired from the circumambient radiation, and that in consequence all reactions are in the broadest sense of the term photochemical. The energy supplied to one molecule so as to make it "active" to undergo the given reaction, whether it be explosion or combination with another active molecule, is assumed to be supplied by radiation of a particular frequency, and in amount equal to $h\nu$, where h is Planck's constant.

For all the ordinary chemical reactions the amount of energy of activation to be supplied, as calculated by application of the fundamental equation of Arrhenius to the temperature coefficient of the reaction, is sufficiently small as to permit of the utilisation of quanta in the infra-red portion of the spectrum; for some reactions, however, visible or ultra-violet light will be necessary, whilst for accelerating the rate of change of radio-active decomposition ultra-X-rays would be required.

The equation of Wien on radiation intensity, and of Arrhenius on the temperature coefficient of chemical reactions bear a formal resemblance to one another, and it is not doubted that the same fundamental properties of matter and of radiation account for the similarity. It is further admitted that the quantum theory of Planck, applied by Bohr to the internal structure of the atom, is likewise valid in many physical and chemical operations, such as calculation of the latent heats of change of state, the heats of formation of chemical compounds, including heats of ionisation and the photoelectric effect. More recently the quantum theory has been applied with success to a general study of reaction kinetics, and it is now evident that there is no essential difference between a typical monomolecular chemical reaction, such as the decomposition of phosphine, and a physical reaction like evaporation. It cannot be doubted that both physical and chemical forces are identical in their nature and also in their mode of action.

The opponents of the theory admit these premises, but see no reason to assign to radiation the important *rôle* given to it by its adherents, and prefer to attribute the two phenomena to some common, but as yet unknown, property, giving rise to these apparent similarities.

The supporters of the theory point out that in fact many photochemical reactions do exist, and, thus admitting the possibility of the direct action of radiation on matter in causing both physical and chemical change, there is no reason why this property should not be universal.

In the development of the theory in its quantitative aspects, however, certain difficulties have arisen necessitating a modification of the simple theory originally proposed; thus the rate of decomposition of phosphine has been accurately determined over a wide range of temperature, the frequency of the radiation necessary to bring about its decomposition calculated from the reaction temperature coefficient, and the amount of energy flowing into the reaction chamber per c.c. per second at the observed temperature calculated from Planck's law. It has been found that there is not enough energy supplied by radiation to account for all the explosions actually observed.

To account for this serious discrepancy several hypotheses may be advanced. Thus we may assume that during the explosion of one phosphine molecule, which has already been activated by the absorption of one quantum of radiant energy, energy is radiated and absorbed by another molecule or by other molecules. Since it is not permissible to assume absorption in fractions of a quantum, it is necessary to adopt an hypothesis of activation of the phosphine molecule by a number of smaller quanta (infra-red)

instead of one big quantum; this in turn seriously affects the logic of the deduction of the energy of activation from the temperature coefficient of the reaction.

Again, we may assume that when there is a continuous drain on one portion of the spectrum by absorption of the light of one particular frequency, the rest of the spectrum undergoes a continuous redistribution of the energy involving an increase in the absorbed radiation density and a decrease in the density of the radiation of greater and smaller wavelength. To account for such an hypothesis we must assume that there is some mechanism for the absorption of these rays in order to effect the redistribution, the purely monochromatic character of the reaction being thus lost, and a parallelism between these thermo- and photo-chemical reactions no longer exists. It is, of course, evident that such a redistribution of the energy does not take place when a reaction is illumined with ordinary visible light, since definite absorption bands are noted, and the rest of the energy either passes through the reaction chamber or is scattered from the molecule surfaces. A third hypothesis involves the assumption that the radiation density inside the actual molecules themselves is the important factor, and one which is greatly influenced by the refractive index of the molecule; computations on these lines lead to high values for the refractive index of the region inside the molecules which await other independent confirmation.

A second difficulty has been raised by a study of hydrolytic operations, *e.g.* sucrose; the temperature coefficient of the reaction indicates an activating frequency in the infra-red portion of the spectrum. Illumination with bright sunlight should cause a very great increase in the reaction velocity; no perceptible effect is actually observed. It is, however, possible to attribute the comparative inertness of these reactions to the strongly absorbent character of the environment to light of long wave length; and it has been suggested that a study of the reaction velocity in thin films under illumination might lead to positive results.

Of significance is the fact that the substance for which the activating frequency has been calculated from the temperature coefficient frequently shows no absorption band in that region. If the hypothesis be adopted that the activating frequency calculated in this manner is only a mean value, *i.e.* the possibility of activation in stages be envisaged, we are confronted with a difficulty in calculating the reverse operation, viz. the reaction velocity from a knowledge of the complete spectrum of the reacting system, since we have no information as to the manner of the distribution of the partially activated molecules.

The debate served clearly to emphasise the relationship of the quantum hypothesis to chemical action, and the fact that the radiation theory was not entirely convincing, but, on the other hand, it certainly contains the germ of the solution to the problem of the mechanism of the interaction of matter and radiation.

The Teaching of Geography.

IN opening the discussion on the teaching of geography at a joint meeting of the Sections of Geography and Education of the British Association at Edinburgh on September 9, Mr. G. G. Chisholm laid stress on the physical basis of geography, but urged the importance of regarding the physical agencies not so much as changing the face of Nature as influencing the distribution of man and his activities. Mr. Chisholm pointed out that geographers have now reached a considerable measure of agreement in the work included under the head of geography. That agreement marks a step in the better recognition of geography in the educational curriculum. At a later stage in the discussion Dr. H. R. Mill dwelt on the urgent necessity of quantitative work in geographical research, and pointed out the enormous field of study which this opens.

Sir Richard Gregory spoke of the position of geography in relation to other science subjects in the school curriculum. He advocated a course of general science as more useful for a general education than the beginnings of heat and light and the laws of chemical action for pupils up to the age of sixteen. A course in geography for all pupils up to that age would at the same time provide the unifying principle for all the science work, bringing it into relation with the activities of man. After such a course it would be equally easy for pupils to specialise in mathematics, physics, chemistry, or geography. At present there tends to be a gap in geographical teaching between school and university work, because few schools have geography teachers capable of carrying the subject to a standard equivalent with the teaching in chemistry and physics.

Mr. W. H. Barker deprecated the tendency to divide studies into watertight compartments, and insisted that the teaching in geography must be given, not by the science master, but by a geography specialist who by his training is fitted to bring out the unifying influence of the subject. Geography serves to unite the two main groups of subjects, natural sciences and humanities, and therein lies its great educational value. To reunite the specialisations is the function of the geography teacher.

Some of the difficulties of getting adequate recognition of geography in the university curriculum were pointed out by Dr. Rudmose Brown. The rigid division of studies into the faculties of arts and science is only slowly breaking down, and, in consequence, geography has a fight to find its true position. The geographer has a definite outlook, and his subject is the same, no matter in which faculty it is placed. The narrow conception of science as being confined to the so-called natural sciences must give way before geography can find adequate recognition. Meanwhile, the practical result of dividing knowledge by a rigid line of demarcation is reflected in the difficult task of giving students of geography the wide outlook that the subject requires.

A plea for the value of geography in historical study was made by Prof. R. K. Hannay. He complained of the non-geographical attitude of many historians, and urged that students of history should follow courses in geography. Prof. J. W. Gregory, in emphasising the scientific basis of geography, thought that it should be included in the science faculties of universities, but did not disparage its inclusion among arts subjects. While there has been much improvement in geographical education in Scotland in recent years, the subject still suffers from neglect and failure to take its due portion in education. This is most noteworthy in secondary schools. Dr. F. Mort was hopeful of the position of geography in Scottish schools, and quoted figures to show the increased numbers taking advanced work in the subject and taught by specially trained teachers. Prof. J. A. Green regretted that much school geography was above the heads of the pupils, the teacher not in-

frequently using words and ideas that bore no relation to the mental development of the children. He advocated more attention to methods of presenting the matter of geography.

Among many aspects of the subject on which Prof. P. Geddes touched was the necessity for travel, for student and teacher alike, in order to broaden the outlook and bring the study of geography into touch with realities. Geography that relied solely, or even mainly, on maps was as lifeless as anthropology which depended solely on skulls.

Centenary of McGill University, Montreal.

McGILL University of Montreal, which has just been celebrating the centenary of its foundation, has shown of late a capacity for attracting prodigious benefactions, such as may well excite the envy of less fortunate institutions even in America. A gift of 1,000,000 dollars from the Carnegie Corporation, New York, "in recognition of the noble and devoted service and sacrifice of McGill towards Canada's part in the Great War," was followed by subscriptions last year by citizens of Montreal and graduates amounting to more than 4,000,000 dollars, a grant of 1,000,000 dollars by the Quebec Provincial Government, and 1,000,000 dollars for medical education from the Rockefeller Foundation of New York. To few institutions has it been given to receive within a short space of time such magnificent tributes from such various sources.

The University was founded by the Hon. James McGill, a leading merchant of Montreal, who died in 1813. Among the principal events in its history are: the opening of the Peter Redpath Museum, 1882; opening of Royal Victoria College, founded and endowed by the late Lord Strathcona as the Women's Department of the University, 1899; opening of Macdonald College, founded and endowed by the late Sir Wm. C. Macdonald, including the School of Agriculture, School for Teachers, and School of Household Science, 1907; gifts of estates valued at 1,117,640 dollars by Sir Wm. C. Macdonald, and of 1,500,000 dollars by various donors, chiefly Montreal citizens, 1911.

Of McGill's two most important professional schools, the Medical and the Engineering, the former will itself soon be able to celebrate its centenary, its first session having been opened in the Montreal Medical Institution in November, 1824. Engineering courses were first established thirty years later. They are now organised on a system thus described by the principal, Sir Arthur Currie, in an address delivered at the Congress at Oxford last July: "Four academic sessions of formal instruction, with the accompanying laboratory, drawing-room exercises, and shop-work, alternating with three summers of practical experience in some branch or branches of the work of the student's future profession." Among recent developments in the advanced courses in chemical engineering is the provision for instruction in the technology of the paper industry, for which the Government Forests Products Research Institute, adjacent to the University, affords special facilities.

Canadian Insect Pests.

IN the Report of the Dominion Entomologist and Consulting Zoologist for the years 1917–18 the late Dr. C. G. Hewitt presents a record of much useful work carried out on behalf of the Canadian Government. During the two years under review the work of controlling the brown-tail moth in Nova Scotia and New Brunswick is regarded as satisfactory, but it is solely due to the careful scouting for, and destruction of, the winter webs during each winter. The control of several indigenous insects is being attempted by means of the introduction and dissemination of their parasites. The "mussel scale" is largely preyed upon by the predaceous mite *Hemisarcoptes malus*, and colonies of the latter have been liberated in infected orchards; the future of the experiment will be awaited with interest. The cabbage-root maggot continues to extend its ravages, and not only was the value of tarred felt-paper discs again demonstrated, but promising results were also obtained with bichloride of mercury. A remarkable and extensive outbreak of the sugar-beet webworm, *Loxostege sticticalis*, occurred in the Prairie Provinces. The millions of migrating caterpillars caused much alarm among the farmers, but, as usual, they confined their attention in the fields to weeds, and the only cultivated crops attacked were garden plants. Owing to the increasing prevalence in many parts of Canada of insects affecting livestock, special attention is now being given to these pests, in conjunction with the Health of Animals Branch of the Department of Agriculture. A joint study has been entered upon with reference to the bot-flies of horses, and many new facts have been discovered relating to their life-histories from the point of view of preventive measures. Entomologists will also be interested in the plans of an underground insectary which are appended to this report. It is hoped by such a contrivance to overcome the difficulties in conducting investigations on soil-infesting insects, particularly during the high temperature which prevails in the summer months.

University and Educational Intelligence.

CAMBRIDGE.—Dr. O. Inchley, St. John's College, has been appointed assistant to the Downing professor of medicine, and Mr. C. Warburton, Christ's College, has been re-appointed demonstrator in medical entomology.

GLASGOW.—The University Court has appointed Dr. Percy A. Hillhouse to the John Elder chair of naval architecture and marine engineering in succession to Sir John Biles, retired. Prof. Hillhouse was appointed in 1898 the first European professor of naval architecture in the Imperial University of Tokyo. Since 1907 he has been the chief naval architect to the Fairfield Co., Govan. The Court has also promoted Dr. William J. Goudie from the lectureship in heat engines in the University to the newly established James Watt chair of the theory and practice of heat engines, endowed in commemoration of the James Watt centenary by the Institution of Engineers and Shipbuilders, Glasgow. Dr. Goudie was formerly reader in the University of London.

The University Court has appointed Dr. G. W. O. Howe, head of the department of electrical standards and measurements at the National Physical Laboratory, to be the first James Watt professor of electrical engineering in the University of Glasgow. From 1909 to 1921 Prof. Howe was assistant professor of electrical engineering in the Imperial College of Science and Technology (City and Guilds), South Kensington. He is recorder of the Engineering Section of the British Association and editor of the *Radio Review*. The new chair was one of those endowed by the Institution of Shipbuilders and Engineers of Glasgow in commemoration of the James Watt centenary.

LIVERPOOL.—The University has been bequeathed the sum of 20,000*l.* by the late Mr. Richard Braithwaite, of Liverpool.

MANCHESTER.—Dr. J. K. Charlesworth has resigned the senior lectureship in geology as from December 25, 1921, upon his appointment to the chair of geology in the University of Belfast.

The following appointments have been made:—Mr. J. S. Wrigley, assistant lecturer in engineering; Dr. R. A. Webb, demonstrator in pathology; Mr. J. H. Blackaby, assistant lecturer in physics; Mr. Arthur Adamson, lecturer in physics in the faculty of technology; and Mr. H. N. Mercer, assistant lecturer in physics in the faculty of technology.

OXFORD.—The following elections and appointments have been made at Balliol College: Dr. J. W. Nicholson, lately professor of mathematics in the University of London, King's College, to a War Memorial Fellowship as tutor in mathematics and physics; Mr. A. O. Ponder, Rhodes Scholar, to a lectureship in chemistry, and Mr. C. R. Morris to a lectureship in philosophy.

SHEFFIELD.—The following appointments have been made by the Council: Mr. H. P. Lewis, assistant lecturer in geology during the absence of the professor; Mr. E. H. Eastwood, demonstrator in pathology and bacteriology in succession to Dr. N. E. Challenger; and Mr. A. J. Chappell to be assistant lecturer in mechanical engineering.

MR. L. BOLTON, winner of the 1000*l.* prize offered by the *Scientific American* for the best essay on Einstein's theory, will give two lectures on "Relativity" at Birkbeck College, Fetter Lane, E.C.4, on Mondays, October 24 and 31, at 5.30. Admission is free, without ticket.

IN connection with the paper-making classes at the Battersea Polytechnic, a film showing "The Manufacture of Newspaper in Canada—from Standing Timber to Finished Sheet," will be displayed under the auspices of the Technical Section of the Paper Makers' Association of Great Britain and Ireland on Monday next, October 24, at 7.15 p.m. Admission is free to all interested in the paper trades.

THE first Report of the British Association Committee on Training in Citizenship has been published in pamphlet form, and can be obtained from the Secretary, 10 Moreton Gardens, S.W.5 (single copies, 1*s.* each, 9*s.* per dozen, 3*l.* per hundred). The report contains the syllabus of a text-book of civics, Lord Lytton's scheme for organising regional study, notes of lessons on regional survey, and schemes for training adopted in some county council schools.

IN celebration of the four hundredth anniversary of Cambridge printing a dinner will be given by the Vice-Chancellor and the Syndics of the University Press on November 10 in the hall of Corpus Christi College. It is stated in the University Calendar that the rights of the University in connection with printing date from 1534, but the acquisition of the present site of the Press began in 1762 and the erection of the existing buildings in 1804. The building known as the Pitt Press, which faces Trumpington Street, was completed in 1832 from part of the funds raised to establish a memorial to the younger Pitt. With reference to the early date at which the University acquired printing rights, it is interesting to note that it was only in 1476, about sixty years previously, that William Caxton set up the first printing press in England, in the precincts of Westminster Abbey.

Calendar of Scientific Pioneers.

October 20, 1896. François Félix Tisserand died.—Prominent among French astronomers of last century for his researches in mathematical astronomy, Tisserand was called to the Paris Observatory by Leverrier, in 1878 succeeded to Leverrier's chair in the Academy of Sciences, and in 1892 followed Mouchez as director of the observatory. It has been said his "Traité de Mécanique Céleste" is worthy to stand beside the "Mécanique Céleste" of Laplace.

October 20, 1894. Charles Carpmael died.—A fellow of St. John's College, Cambridge, and a writer of mathematical papers, Carpmael settled in Toronto in 1872, and became head of the Canadian weather service. In 1885 he was President of the Canadian Royal Society.

October 21, 1886. Frederick Guthrie died.—Trained in England and Germany as a chemist, Guthrie turned his attention to physics, became professor at the Royal College of Science, and in 1874 took the initiative in founding the Physical Society.

October 22, 1871. Sir Roderick Impey Murchison died.—Originally a military officer, Murchison began his career as a man of science at the age of thirty. A great geological observer, his name is especially associated with the Silurian system, and with the geological survey of Russia. He foreshadowed the discovery of gold in Australia. In 1855 he succeeded De la Beche as director of the Geological Survey of Great Britain, and he was the founder of the chair of geology at Edinburgh.

October 23, 1841. Johan August Arfvedson died.—A member of the Stockholm Academy of Sciences, Arfvedson wrote much on minerals, and in 1817 discovered the metal lithium.

October 24, 1601. Tycho Brahe died.—Noble by birth and rich by inheritance, Tycho alienated his family by his devotion to astronomy, but secured the friendship of Frederick, King of Denmark, who gave him the island of Hven, and enabled him to build the most splendid observatory ever seen. Here for twenty years Tycho and his assistants observed the heavens with an accuracy hitherto unknown. From various causes, in 1597 the observatory was abandoned, and Tycho migrated to Prague, where Kepler became one of his assistants.

October 24, 1655. Pierre Gassendi died.—Theologian, philosopher, mathematician, and astronomer, Gassendi was a provost at the cathedral at Digne, and in 1645 accepted the chair of mathematics in the College Royal in Paris, where he enjoyed a European reputation. He was the first to observe a transit of Mercury.

October 24, 1873. Frederick Crace Calvert died.—An assistant to Chevreul, and afterwards a manufacturer in Manchester, Calvert carried out many chemical researches, and to him is mainly due the use of carbolic acid as a disinfectant and for therapeutic purposes.

October 24, 1892. Robert Grant died.—The author of a valuable history of physical astronomy, Grant, in 1859, succeeded Nichol as professor of astronomy at Glasgow. Among his labours was the compilation of two catalogues of stars, one published in 1883, containing 6415 stars, and the second, published in 1892, containing 2156 stars.

October 25, 1647. Evangelista Torricelli died.—The first to demonstrate the pressure of the atmosphere and the inventor of the barometer, Torricelli after the death of Galileo in 1642 became mathematician to the Grand Duke of Tuscany. E. C. S.

Societies and Academies.

PARIS.

Academy of Sciences, October 3.—M. Léon Guignard in the chair.—J. **Costantin**: Alpine biology. The modifications of the fungus *Pleurotus Eryngii* produced by an Alpine climate.—A. **Rateau**: A new locking screw nut. The system described and figured is suitable only for special work in which the cost is not of first importance. It permits an adjustment of the screw to 1/240th of a turn, with an absolutely safe lock.—G. **Giraud**: Non-linear partial differential equations of the second order of the elliptical type.—M. **Drouin**: Contribution to a general study of unlimited algorithms.—O. **Cahen**: A new aerial float. The use of an evacuated rigid envelope (sheet aluminium on a wooden framework) is suggested in place of a non-rigid balloon filled with a light gas.—L. **Rodès**: Does the earth exercise an influence on the formation of sunspots?—E. **Perucca**: The Volta effect in a vacuum and in highly rarefied gases. The couples studied included Zn | Hg, Cd | Hg, Bi | Hg, and Sb | Hg, the experiments with the Zn | Hg couple being given in detail. There would appear to be a Volta effect in the absence of a superficial gas layer, −0·17 volt for Zn | Hg. Water vapour exerts no special influence on the voltages, but the effect of oxygen, even when dry, is very marked.—M. **Curie**: The action of the infra-red rays on phosphorescence. According to a recent theory of Ives and Lukiesh, there should be a diminution in the intensity of the X-rays reflected from the 110-face of a crystal of cubic blende when infra-red radiation is allowed to fall on the face of the crystal. The experiment has been made by the author, with a negative result.

WASHINGTON, D.C.

National Academy of Sciences, Proceedings, vol. 6, No. 8, August, 1920.—G. P. **Merrill**: On chondrules and chondritic structure in meteorites. A study with detailed bibliography discussing the nature and origin of the chondrule.—A. A. **Michelson**: The vertical interferometer. The vertical interferometer is designed to obviate the difficulties of maintaining parallelism of the moving mirror.—A. A. **Michelson**: On the application of interference methods to astronomical measurements. A report on the determination of the orbit of Capella.—A. A. **Michelson**: A modification of the revolving mirror method for measuring the velocity of light.—W. **Duane** and W. **Stenström**: On the K series of X-rays. Data are provided for testing the following: (*a*) The existence of a third line in the α-group; (*b*) the separation of the critical adsorption from the line of shortest wave-length in the emission spectrum, namely, the γ-line; (*c*) the experimental and theoretical relations between the various lines in the K, L, M, etc., series; (*d*) the relative intensities of the emission lines; and (*e*) the equations for the wave-lengths that may be deduced from theories of the structure of atoms and the mechanism of radiation.—H. **Shapley** and Helen N. **Davis**: Studies of magnitude in star clusters, XII. Summary of a photometric investigation of the globular system Messier 3.—F. **Boas**: The influence of environment upon development. A discussion of several series of observations resulting apparently in a confirmation of the conclusion that environmental conditions play an important part in the determination of the bodily form of the adult.—R. H. **Goddard**: The possibilities of the rocket in weather forecasting. A discussion of the rocket as a means of realising the conditions desirable for obtaining high altitude data, and the extent to which the conditions necessary for a satisfactory rocket method have been realised.—C. **Barus**: Note on a pneumatic method of measuring variations of the acceleration of gravity.—C. **Barus**: Note on torsional measurement of variations of the acceleration of gravity by interference methods.—D. H. **Campbell**: The genus Botrychium and its relationships.

Books Received.

The Fixation of Atmospheric Nitrogen. By Dr. J. Knox. (Chemical Monographs.) Second edition. Pp. vii+124. (London: Gurney and Jackson.) 4*s*. net.

Rocks and Fossils and How to Identify Them. By J. H. Crabtree. Pp. 63. (London: The Epworth Press.) 1*s*. 9*d*. net.

Notes on Inorganic Chemistry for First-Year University Students. By Prof. F. Francis. Pp. viii+244. (Bristol: J. W. Arrowsmith, Ltd.; London: Simpkin, Marshall and Co., Ltd.) 8*s*. 6*d*. net.

Australasian Antarctic Expedition, 1911–14, under the Leadership of Sir Douglas Mawson. Scientific Reports. Series C: Zoology and Botany. Vol. 6, Part 3: Polychæta. By Dr. W. B. Benham. Pp. 128+plates 5–10. (Sydney: Government Printing Office.) 12*s*.

Selected Poems in Somerset Dialect. (The Somerset Folk Series, No. 1.) Pp. 99. (London: Somerset Folk Press.) 1*s*. 6*d*. net.

A Practical Handbook of British Birds. Edited by H. F. Witherby. Part 12. Pp. 257–352. (London: H. F. and G. Witherby.) 4*s*. 6*d*. net.

Publications of the University of Manchester: Economic Series, No. 16. Bleaching: Being a *Résumé* of the Important Researches on the Industry Published during the Years 1908–20. By S. H. Higgins. Pp. vii+137. (Manchester: University Press; London: Longmans, Green and Co.) 10*s*. 6*d*. net.

Fifty Years of Electricity: The Memories of an Electrical Engineer. By Prof. J. A. Fleming. Pp. xi+371+plates. (London: Wireless Press, Ltd.) 30*s*. net.

The Riddle of the Rhine: Chemical Strategy in Peace and War. By Victor Lefebure. Pp. 279. (London: W. Collins, Sons and Co., Ltd.) 10*s*. 6*d*. net.

Shooting Trips in Europe and Algeria: Being a Record of Sport in the Alps, Pyrenees, Norway, Sweden, Corsica, and Algeria. By H. P. Highton. Pp. 237. (London: H. F. and G. Witherby.) 16*s*.

A History of the Whale Fisheries: From the Basque Fisheries of the Tenth Century to the Hunting of the Finner Whale of the Present Date. By Dr. J. T. Jenkins. Pp. 336. (London: H. F. and G. Witherby.) 18*s*.

An Introduction to Organic Chemistry. By D. Ll. Hammick. Pp. viii+258. (London: G. Bell and Sons, Ltd.) 6*s*.

An Inquiry into the Nature and Causes of the Wealth of Nations By Dr. Adam Smith. (Bohn's Standard Library.) Reprinted from the sixth edition. Vol. 1. Pp. xxxvi+502. Vol. 2. Pp. vi+552. (London: G. Bell and Sons, Ltd.) 2 vols., 12*s*. net.

Plane Geometry: Practical and Theoretical *Pari Passu*. By V. Le Neve Foster. (Mathematical Series for Schools and Colleges.) Vol. 1. Pp. xi+220+xi. Vol. 2. Pp. xii+220–422+xi. (London: G. Bell and Sons, Ltd.) 3*s*. each vol.

Botany for Students of Medicine and Pharmacy. By Prof. F. E. Fritch and Dr. E. J. Salisbury. Pp. xiv+357. (London: G. Bell and Sons, Ltd.) 10*s*. 6*d*. net.

The Psychology of Thought and Feeling: A Conservative Interpretation of Results in Modern Psychology. By Dr. C. Platt. Pp. x+290. (London: Kegan Paul and Co., Ltd.) 7s. 6d. net.

A History of British Mammals. By G. E. H. Barrett-Hamilton and M. A. C. Hinton. Part 21. Pp. 697-748+plates. (London: Gurney and Jackson.) 3s. 6d. net.

Cane Sugar: A Text-book on the Agriculture of the Sugar Cane, the Manufacture of Cane Sugar, and the Analysis of Sugar-House Products. By Noel Deerr. Second (revised and enlarged) edition. Pp. viii+644+29 plates. (London: Norman Rodger.) 42s. net.

Diary of Societies.

THURSDAY, OCTOBER 20.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—G. Brewer: The Langley Machine and the Hammondsport Trials.

CHEMICAL SOCIETY, at 8.—R. L. Grant and F. L. Pyman: Nitro- and Amino-derivatives of 4-Phenylglyoxaline.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Commercial Vehicle and Motor Car and Marine Exhibitions, Olympia).—T. Clarkson: Coke as a Fuel for Commercial Vehicles.—W. D. Williamson: Leading Devices for Commercial Vehicles.

FRIDAY, OCTOBER 21.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 5.—Presidential Address by Dr. Logan Turner: The Structural Type of the Mastoid Process based upon the Skiagraphic Examination of 1000 Crania of Various Races of Mankind.—Dr. Watson-Williams and E. Watson-Williams: A Method of Diagnostic Exploration of the Posterior Ethmoidal Cells.——(Electro-Therapeutics Section), at 8.30.—Presidential Address by Dr. E. P. Cumberbatch: Progress in Electrology and Radiology: The Importance of Physics, Physiology, and Anatomy.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science, South Kensington), at 5.—S. Butterworth: (1) On the Use of Anderson's Bridge for the Measurement of the Variations with Frequency of the Capacity and Effective Resistance of a Condenser. (2) The Elimination of Earth Capacity Effects in Alternating Current Bridges.—F. G. H. Lewis: An Automatic Voltage Regulator.—Prof. A. S. Hommy The Flow of Viscous Liquids through Slightly Conical Tubes.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Dr. W. Rosenhain, S. L. Archbutt, and Dr. D. Hanson: Eleventh Report to the Alloys Research Committee on Some Alloys of Aluminium.

MONDAY, OCTOBER 24.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Meeting), at 7.—R. E. Light: The Efficient Utilisation of Steam and Electric Power in Factories.

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—Presidential Address by Mr. M. Hopson.—J. B. Parfitt: The Treatment of Pulpless Teeth.

MEDICAL SOCIETY OF LONDON, at 8.30.—Sir Archibald Garrod, and Others: Discussion on the Modern Treatment of Diabetes.

TUESDAY, OCTOBER 25.

ROYAL SOCIETY OF MEDICINE (Medicine Section), at 5.30.—Dr. W. W. Payne and Dr. E. F. Poulton: Epigastric Pain.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—T. F. McIlwraith: The Influence of Egypt on African Death Ceremonies.

SOCIOLOGICAL SOCIETY, at 8.15.—R. Unwin: Preparations for the General Adoption of Town Planning.

WEDNESDAY, OCTOBER 26.

ST. MARY'S HOSPITAL MEDICAL SOCIETY, at 8.—Dr. C. Singer: Leonardo Da Vinci as a Man of Science and Anatomist.

THURSDAY, OCTOBER 27.

INSTITUTION OF MINING AND METALLURGY (at Geological Society's Rooms), at 5.30.—L. Hill: Ventilation and Human Efficiency.—J. N. Justice: Notes on the Ore Deposits of Eagle Mountain, Demerara.

CHILD-STUDY SOCIETY (at Birkbeck College), at 6.—Discussion on Individual Training in the School.—Miss Bassett: The Dalton Plan.—Miss Mackinder: Individual Work.—Mrs. Bottrill: Vertical Classification.

EGYPT EXPLORATION SOCIETY (at Royal Society Rooms), at 8.30.—P. E. Newberry: Early Relations of Egypt, Babylonia, and Syria.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—Presidential Address by Sir Thomas Horder: The Medical Aspect of Some Urinary Diseases.

FRIDAY, OCTOBER 28.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Continuation of Discussion on the Eleventh Report of the Alloys Research Committee on Some Alloys of Aluminium.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.—Presentation of Jenner Medal to Sir Shirley Murphy by the President.—Dr. L. G. Haydon: Plague in Wild Rodents in South Africa.

PUBLIC LECTURES.

(A number in brackets indicates the number of a lecture in a course.)

THURSDAY, OCTOBER 20.

UNIVERSITY COLLEGE, at 4.—Dr. T. G. Pinches: Babylonian Magic (3).

FRIDAY, OCTOBER 21.

UNIVERSITY COLLEGE, at 4.30.—Dr. J. C. Drummond: Nutrition (2).

MONDAY, OCTOBER 24.

BIRKBECK COLLEGE, at 5.30.—L. Bolton: Relativity (1).

KING'S COLLEGE, at 5.30.—Dr. W. R. Ormandy: Liquid Fuel Engines (1).

TUESDAY, OCTOBER 25.

KING'S COLLEGE, at 5.30.—Prof. H. Wildon Carr: The Modern Scientific Revolution and its Meaning for Philosophy (3).—The Statistical Character of the Laws of Nature.—Dr. W. Brown: Psychology and Psychotherapy (2).—L. J. Hunt: Cascade Synchronous Motors and Generators (2).

WEDNESDAY, OCTOBER 26.

SCHOOL OF ORIENTAL STUDIES, at 12.—Miss A. Werner: Bantu Tribes of East Africa (2). At 5.—Rev. W. Hopkyn Rees: Chinese Folk Lore.

KING'S COLLEGE, at 4.30.—Dr. C. A. Da Fano: Histology of the Nervous System (3).—At 5.15.—Prof. W. T. Gordon: Geological and Geographical Physical Basis of the British Empire.

THURSDAY, OCTOBER 27.

KING'S COLLEGE, at 5.30.—H. W. Fitz-Simons: Bridge Construction (2).

CONTENTS.

	PAGE
London University Site	233
Travel in North-west China. By J. W. G.	234
Natural History of Pheasants. By W. E. C.	235
Bütschli's Lectures on Comparative Anatomy. By Prof. G. Elliot Smith, F.R.S.	236
Earth-structure. By Prof. Grenville A. J. Cole, F.R.S.	236
Our Bookshelf	237
Letters to the Editor:—	
The Development of Optical Industries.—J. W. Atha and Co.; The Writer of the Article	238
The Tendency of Elongated Bodies to set in the North and South Direction.—Sir Arthur Schuster, F.R.S.	240
Is Scientific Inquiry a Criminal Occupation?—Prof. Henry E. Armstrong, F.R.S.	241
Radiation and Chemical Action.—Prof. W. C. McC. Lewis	241
Habits of the Hedgehog.—Miller Christy	242
The Flight of Thistledown.—Miles Walker	242
A Method of Improving Visibility of Distant Objects.—Prof. C. V. Raman	242
Gold-coloured Teeth of Sheep.—Thos. Steel	242
The Constitution of Molecules.—Prof. J. R. Partington	242
The Laboratory of the Living Organism. By Dr. M. O. Forster, F.R.S.	243
Metaphysics and Materialism. By Prof. H. Wildon Carr	247
Damascene Steel and Modern Tool Steel	248
Obituary:—	
Dr. Julius Hann. By Sir Napier Shaw, F.R.S.	249
Benjamin Harrison	251
Notes	251
Our Astronomical Column:—	
The Lunar Eclipse of October 16	256
Reform of the Calendar	256
The Spectrum of ϕ Cassiopeiæ	256
Minor Planets	256
The Centenary of *Astronomische Nachrichten*	256
Geology of the South Wales Coalfield	257
National Institute of Agricultural Botany. (*Illustrated*)	258
Chemical Reactivity and the Quantum Theory. By Dr. Eric K. Rideal	259
The Teaching of Geography	260
Centenary of McGill University, Montreal	261
Canadian Insect Pests	261
University and Educational Intelligence	261
Calendar of Scientific Pioneers	262
Societies and Academies	263
Books Received	263
Diary of Societies	264

THURSDAY, OCTOBER 27, 1921.

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A Tropical College of Agriculture.

THE establishment of well-equipped agricultural colleges in some of our more important tropical colonies has long been regarded as highly desirable by men of vision to be found, more often than some are willing to admit, among the administrators of our overseas dominions and the teachers of agriculture in this country, among planters abroad and business men at home. The most sanguine and far-seeing advocates of this policy have never urged an immediate and wholesale application of the idea. All they have ventured to hope for, at least at the outset, has been the establishment of one such college, preferably in the West Indies, to serve the needs of our West Indian and West African colonies, and of a second, somewhere in the tropics of the old world, to serve the needs of our colonies in East Africa and South-eastern Asia. The official intimation by the Secretary of State for the Colonies that on September 21 the governing body of a West Indian Agricultural College, which is to work in affiliation with the Imperial Department of Agriculture in the West Indies, had been formally constituted, affords some assurance that at least one moiety of the modest wish of those who care for the Empire and its peoples may be fulfilled.

Those who have urged the foundation of institutions such as that of which the incorporation has now been announced share the feeling that their existence must lead to more precise acquaintance with the conditions under which tropical crops are raised, and to the provision of instruction in the methods of tropical agriculture more satisfactory than anything hitherto available for those who wish to pursue a planting career.

In this particular case the influence of the new institution will not be confined to the colony of Trinidad, which has offered the land required for the erection of the college buildings and of the residences for the teaching staff. Like similar tropical colleges already established by the United States Government in Porto Rico, Hawaii, and elsewhere, to which students are attracted from all parts of America, the new college may be expected to draw its students from colonies other than Trinidad and from regions beyond the West Indies. It may, indeed, like the American Institutions alluded to, prove as important from a home as from the colonial point of view, if the opportunity be taken to establish between the Trinidad College and the agricultural schools in this country a reciprocal relationship under which students in the latter are enabled to spend part of their period of professional study in Trinidad, there to receive practical instruction in tropical methods and to acquire familiarity with tropical conditions.

The importance, from the Imperial point of view, of institutions like the West Indian Agricultural College promises to be more than academic. The existence of such colleges can scarcely fail to further that increase in the output of cultivated tropical raw materials which is so urgently called for in the interests of the Empire. Their influence may in time even lead to that fuller understanding of tropical products, by those who handle them in this country, which is so greatly to be desired.

There is a certain fitness in the circumstance that the first tropical agricultural college to be founded in the Empire should owe its existence to the initiative of the West Indies, which include some of the oldest of our colonial possessions. There will be a widespread desire that the success of the new institution may equal that attained by the similar colleges established by the Government of the United States and be such as to lead to the foundation of institutions of the same kind in those other overseas possessions where they are required.

Cellulose Esters.

Technology of Cellulose Esters. (In Ten Volumes.) By E. C. Worden. Vol. 1, part 1, *Cellulose, Starch, Cotton.* Pp. cxxv + 664. Part 2, *Nitric, Sulfuric, Mixed Acids.* Pp. cxvii + 665–1566. Part 3, *Nitrocellulose: Theory, Practice.* Pp. cxvii + 1567–2376. Part 4, *Historical Development.* Pp. cxvii + 2377–3086A. Part 5, *Index.* Pp. 3087–3709. (London: E. and F. N. Spon, Ltd., 1921.) 10*l.* 10*s.* net (five parts).

THE child whose first sight of a giraffe called forth the ejaculation, "I don't believe it," represents the reviewer ruminating on the first impression produced by this work, vol. 1, in five parts—literally five robust volumes—representing 18½ lb. of actual weight, and presumably 10*l.* 10*s.* of value as claimed. The impression is deepened by the author's "Announcement and Preface," which sets forth his aim and constructive conception of the work, the present volume, and the nine to follow! The incidental statistics will make a strong appeal to the mere megalophile. The preparation of the data has involved 365,000 index-cards; the matter deals with the work of 55,000 investigators, involving 350,000 references to technical-scientific literature. These figures should produce a moral impression on the external world —external, that is, to the "world" of cellulose, of which the author will be acclaimed as histriographer-, if not cartographer-, in-chief.

To the world at large and the English-speaking world in particular, "cellulose" has been little more than a name, and "ester" a specimen of a barbarous terminology quite remote from the "things that matter." Nevertheless, cellulose esters were a dominating factor of the great war and "cellulose" connotes many of the primary necessities and joys of daily life.

It is evidently impossible in a review to convey, even to the trained mind of the critical student, any adequate digest of the contents of a work of really colossal range. The attempt, moreover, would be gratuitous, for its character is that of an encyclopædia. It has not the aim of a text-book, and although the author claims that "its statements are aimed at the intelligence of a sympathetic human being," we cannot take this point of view in commending the book, for the emotions are not touched by technical records and statistics, and it requires a sympathetic temperament of an unusual order to draw inspiration from a museum.

We have prepared the reader for a really spontaneous tribute to the author in achieving a work which has involved twenty-five years of labour. The present result, only an instalment, is evidence of such long-sustained perseverance, of great ability, of courage, and all the qualities associated with moral enthusiasm. With the experience of a still longer connection with the subject-matter, we have tested vol. 1 in regard to selected typical "topics"—to use a favourite term of the author's —and find the information exhaustive, accurate, and, by reason of sound method in indexing, readily accessible.

It should be noted in regard to the plan of the work that chaps. 1–3, constituting sectional vol. (part) 1, of 664 pages, deal with "Cellulose," "Starch," and Cotton," and together form a generalised foundation for the main subject. The treatment follows no general systematic order, though the sections are in many cases an *exposé* in logical sequence, as, for example, the section on "Cellulose Analysis," contributed by J. F. Briggs.

It is clear that the work was not planned *ab initio*, but has grown as a compilation and an agglomerate; the author has continued his compilation, and the accretions of contributors and collaborators have been selected and incorporated from time to time. Thus the work has evolved as a compilation, an agglomerate and also conglomerate: for science and technology, abstractions and utilities, the essential and the trivial are put together, without apparent method, *i.e.* without subordination to the perspective of first principles.

This does not detract from the great value of the work to the already instructed, the specialist, whether of science or technology, seeking to inform himself on the records of research or technical development to date. Such readers of critical habit will methodise the matter in reading, whereas the general reader or student of science or technology would rapidly reach discouragement and mental indigestion.

As a work to be recognised as a standard book of reference it is only right to examine it as a literary production. The author's mentality, to use his own word, and style are revealed in a prolix "Announcement and Preface," occupying six closely printed pages. Opposite the first page, on an otherwise blank sheet, the author has printed a three-line exordium:—

> "Work for the night
> **is coming, when**
> Man's work is done."

The punctuation being as reproduced, and the middle line in prominent type, the effect of the paraphrase is confusion and shock. We remember

a verse in the "Paraphrases" of the U.P. Church:

> "The Lord will come and He will not
> Keep silence but speak out,"

which, declaimed line by line, produced a similar effect. Early in the preface proper we have the sentence: "Be it monumental, or otherwise, every effort of attempted merit has a definite aim." The author is thinking big things, and perhaps with clear meaning to himself, but his words merely paralyse the reader. The paragraph goes on to reveal the author's central purpose:—

"The aim of the work is to present the entire subject of the combinations of normal and modified celluloses, with acidyl and alkyl radicals, in such completeness, clarity, accuracy, and detail, that inability to locate the information desired in the collective index will be positive evidence that the matter sought was either ephemeral, irrelevant, inaccurate, non-existent, or valueless!"

It would have been easy to have said: "The work is devised as a comprehensive and exhaustive account of the cellulose esters, subserving constructive science, and with critical exclusion of the ephemeral and valueless. It is claimed for the collective index that it is final as a record of such critical selection." This is probably the expression of the author's claim, whereas he leaves the reader to conclude that the main value of the work is its collective index, and that his chief function has been the winnowing out of the chaff and even the non-existent. This is one of many cases where the author's meaning requires to be interpreted considerably and considerately.

Such curious evaluation of words and language is especially characteristic of the handling of the central subject of nitrocellulose. Thus the important chap. 9 is headed "Nitrocellulose Theory." The author's method, however, is that of recording in chronological sequence the investigations which brought the cellulose nitrates into existence and gradually into use. In a single paragraph forecast there are no indications of theory, and the chapter proceeds through 120 pages of records before arriving at a section headed "Theory of Nitration," upon which he says: "The entire theory and practice of the esterification of the carbohydrates rests at the present time upon an empirical basis and upon a series of assumptions and predictions . . ." a statement which is seriously incorrect. After setting out what he regards as the difficulties in the way of generalisation or theory, he comes to the conclusion, expressed in rhetorical form as follows:—

"It must be obvious to the unbiased, non-speculative, reflective mind conversant with this subject and cognizant of the difficulties embraced therein, that the sum total of contributions of those who have lived and worked and gave, constitute but the denting or etching of the periphery of a vast sphere whose potentialities are practically limitless. Such, at least, are the views of the author."

The form of words and incidental grammar are the author's own. Without emphasising their eccentricity, we suggest that he uses rhetoric as a cloak for the abdication at a critical moment of his true *rôle* as constructive chronicler. The facts are that empiricism has marked most of the stages of evolution of what the author would know as "the art," but there have been definite phases of progress in theory. If the matter had been handled on a definite plan of "theory," as the heading of the chapter would lead one to expect, the records would have been edited in such a way as to follow and forecast progress, and to be a useful guide, not only to research, but also to consequent practical developments. On the subject of "Stability," which involves a leading point in the theory of these esters, viz. the reactions of formation and decomposition, the author avoids his responsibility of setting out the very definite phases of advance, and the reviewer has had to dig out for himself the connected story of this important section. It is only right to say that the records are full, and anyone having general knowledge of the subject can supply the deficiency.

In regard to these volumes as books, the author properly directs attention to the printing of the matter, which is certainly an achievement. The paper he describes as "Olde style," which appears to mean an ultra-modern paper of wood cellulose with from 15 to 20 per cent. loading, and calendered to about one gram per c.c., and weighing 110 grams per sq.m. of surface. This accounts for the excessive weight of the volumes. Moreover, in each volume, *except* the index volume, there is reproduced the author's list of abbreviations of the technical journals quoted—about ninety-two pages! This is an unnecessary addition to weight; there should have been one such list included in the index volume.

We have endeavoured in this inadequate notice to give such an account of the work as will help to secure its proper reception by the technical-scientific public. It is undoubtedly "monumental," and has the greatest possible merit as a record. It is obviously an indispensable addition to the library of all who have a special connection with the subject.

History of Birds in Britain.

Early Annals of Ornithology. By J. H. Gurney. Pp. viii+240. (London: H. F. and G. Witherby, 1921.) 12*s.* 6*d.* net.

ALL who are interested in ornithology should read this book, which gives an excellent account of our knowledge of birds from the earliest times, and of the authorities whence that knowledge is drawn. Mr. Gurney, as he tells us in his preface, is more particularly concerned with Britain; indeed, if more than occasional references were to be made to such European authors as Aldrovandus, Belon, Clusius, and Gesner, the work would become of unmanageable size. After a preliminary survey of prehistoric records we have successive chapters dealing in order with the centuries from the fourth to the eighteenth.

The state of England naturally comes under consideration, and especially that of the Fens and of the Eastern counties, with which the author and his family are so closely connected. The undrained marshlands were formerly the haunt of many birds now rare or exterminated; the warrens and wolds were untouched and the sea coasts little disturbed.

Even during the Roman occupation of Britain we find various species of birds mentioned by early authors. The pheasant is supposed to have been introduced by the conquerors, while the turkey, peafowl, guinea-fowl, and swan become prominent as the years roll by. Fowls and pigeons are of much earlier date.

Falconry was a favourite pursuit of the ancients, which was practised by Saxon or Norman kings as eagerly as by their successors. The gannet, the eagle, and so forth are celebrated in the earliest poems, while we constantly find records of the falcons and hawks used for sport. Aviaries were fairly common things, favoured even by kings. Mr. Gurney considers as worthy of more extended notice the bittern, the bustard, the crane, the gannet, the great auk, and the spoonbill. The black-headed gull comes later into the same category. Swanneries and swan-marks are always a matter of interest, and they are treated very fully, while duck-decoys and similar devices are by no means neglected. Ornithologists are indebted for many pieces of information to the bills of fare of the great feasts of old, while the household accounts of certain families have carefully to be examined. Such are those of Lord W. Howard of Naworth and of the Shuttleworths of Lancashire; but by far the most important are those of the le Straunges of Hunstanton, which have been exhaustively examined by the present head of the family.

Throughout the book we find reference to the great writers of old on birds and science generally, such as Hector Boece, Sir Thomas Browne, Pennant, Pontoppidan, Ray, Turner, and Willughby, not to mention the lesser lights.

The only section of this admirable work where we feel inclined to criticise the author's treatment of his subject is the first chapter. Its title of "Prehistoric Birds" scarcely fits the text, for some of the species mentioned are still in existence, though known from prehistoric times. Again, although we should not expect full details of fossil birds, we should have liked a few words about the earliest known form of archæopteryx and its cretaceous successors. Another possible method would have been to omit all allusions to fossil birds and to start this most interesting chapter with the cave drawings, the Meidonn slab, Aristotle, and Pliny.

Chromium, Platinum, and Lead Ores.

Imperial Institute: Monographs on Mineral Resources, with Special Reference to the British Empire. (1). *Chromium Ore.* By W. G. Rumbold. Pp. ix+58. (1921.) 3*s.* 6*d.* net. (2) *The Platinum Metals.* By A. D. Lumb. Pp. ix+63. (1920.) 3*s.* 6*d.* net. (3) *Lead Ores.* By T. C. F. Hall. Pp. ix+127. 6*s.* net. (London: John Murray, 1921.)

THESE three additions to the Imperial Institute's series of Monographs on Mineral Resources deal respectively with the ores of chromium and lead, and the platinum metals. Those on chromium and platinum are naturally the most complete, for the lead ores are especially varied and widely distributed, and have a longer mining history.

(1) Chromite ores are of particular geological interest, since they are generally claimed to be of direct igneous origin. An account of such evidence as might be yielded by the microscopic structure of the ores as to their mode of formation would have added to the permanent value of the monograph. Mr. Rumbold adopts the view that the Rhodesian chromite ores, though very different in character from those for which the igneous theory was propounded, are not inconsistent with it. This statement of the evidence from all the chromium fields shows, however, that the chromites for which the direct igneous origin is probable form but a small proportion of the commercial ores. Most of the existing supply of chromium comes, not from segregations in dunite

or unaltered peridotite, but from talc-schists in Rhodesia, from a vein in an altered dunite dyke in Mysore, from veins and irregular masses in serpentine in Baluchistan, from veins in bands of serpentine or alluvial deposits derived therefrom in New Caledonia, or from fissure deposits in Cretaceous limestones in Greece. The chromite segregations in dunite (olivine-chromite rock) are too small and low-grade to be worked to any large extent in competition with the ore in the Rhodesian talc-schists.

(2) Mr. Hall's monograph on the platinum metals gives an account of the recent discoveries of platinum due to the vigorous search stimulated by its high price. The metal is found to be very widely distributed, but the author makes the disappointing statement that, in spite of the energy devoted to their investigation, the new localities are not likely to prove important as sources of platinum. The monograph describes the effective substitutes invented by the modern metallurgist that render platinum no longer necessary for many purposes for which it was once indispensable.

(3) The monograph on lead gives a valuable summary and bibliography of the chief lead deposits of the Empire and shorter reference to those of other countries.

Each of the monographs gives an account, for each of the metals dealt with, of its chief ore deposits, of its uses and metallurgy, with bibliographies and a few tables of statistics. Some figures as to output are indispensable in economic geology to show the relative importance of the different modes of ore genesis. The figures quoted are used to supplement the descriptions of the mining fields, and do not involve any serious encroachment on the statistical monographs of the Mineral Resources Bureau. The two series are, indeed, complementary. One is devoted to the statistical side, and the other to the geological occurrence and genesis of the ores, and to the uses and extraction of the metals. So long as each uses matter which belongs primarily to the other series only to illustrate its own problems, both series will be useful for the two different purposes they were designed to serve. J. W. G.

The Phoenicians in Sicily.

Motya: A Phoenician Colony in Sicily. By Joseph I. S. Whitaker. Pp. xvi+357. (London: G. Bell and Sons, Ltd., 1921.) 30*s.* net.

MR. WHITAKER'S investigations on the island of San Pantaleo have for the historian and the archæologist a twofold interest. It may now be said that he has established with reasonable probability that this island is the site of the ancient city of Motya—a question which was not beyond doubt—and he has added very considerably to our knowledge of Phœnician culture.

The island of San Pantaleo lies in a shallow lagoon at the western extremity of Sicily, not far from the ancient Lilybæum. Motya, according to Thucydides, was one of the cities to which the Phœnicians withdrew at the advent of the Greek colonists in the middle of the seventh century B.C. It was involved in the struggle between the Greeks and Carthage, and utterly destroyed by the tyrant Dionysius in 397 B.C. Its position as the centre of Phœnician power and influence in Sicily was taken by Lilybæum, and it was never reoccupied. Owing to this fact, Mr. Whitaker's excavations have been pursued in peculiarly favourable circumstances. Many of the objects brought to light by his spade, even to the very weapons of the combatants, lay where they fell during the siege. No other Phœnician site has remained undisturbed in this way.

It has now been established by the excavations here described that a defensive wall ran around the whole island, with gates at the north and south, and probably gates of less importance at the east and west. In the course of the examination of the remains of this wall a cemetery was discovered, which probably goes back to the days of the earlier settlers. At some time this cemetery was abandoned and a necropolis established on the adjacent mainland. Curiously enough, at the same time the practice of incineration, which had hitherto prevailed, was given up and inhumation introduced. Near-by another cemetery was discovered which contained the remains of domestic animals. The occurrence of the bones of young children among the animal remains suggests that it was a place for the deposit of sacrificial victims.

Greek influence, of which it is known there was a considerable element in Motya, appears in the form and character of a group of buildings, excavated on the south-east slope of the island, in which was found a mosaic pavement of natural pebbles. The design of the pavement was an animal subject—obviously Phœnician—surrounded by a border of the Greek meander.

Mr. Whitaker's investigations practically ceased with the outbreak of war. It is to be hoped that their resumption will bring to light results even more important than those recorded in this book.

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Our Bookshelf.

Les Ressources du Travail Intellectuel en France. By Edme Tassy and Pierre Léris. Pp. xxi+711. (Paris: Gauthier-Villars et Cie, 1921.) 50 francs net.

THE "instruments, aids, and measures of protection and encouragement" which the State and private initiative place at the disposition of brain-workers in France are, the authors of this work assert, generally under-estimated and to a large extent ignored because they are nowhere systematically catalogued. The present work is intended to supply this want and to promote a movement of federation of workers through the agency of learned societies under the guidance of an "Office National Scientifique." The following analysis indicates the scope of the book:—Learned societies and professional associations (including such particulars as dates of their foundation, objects, equipment, publications)—175 pages; societies for the promotion of various studies, intellectual *ententes*, etc.; courses provided by institutions for higher education in Paris, and special courses in the provincial universities; and "Encouragements et Aides Financiers"—100 pages; technical bureaux and services maintained by State Departments, laboratories, museums, libraries and archives, bibliographies and lists of literary and scientific periodicals—300 pages; general information, being lists of annuals and other books of reference, brief accounts of information bureaux, French and international congresses, commissions, and other "Organes d'intercommunication scientifique," miscellaneous notes as to publishing houses, patent and copyright law and agencies connected therewith, translating and stenography agencies, etc.—75 pages.

The chapter on "Encouragements et Aides" includes detailed accounts of the prizes offered by the Academies of the Institut de France, of Medicine, and of Agriculture; information about other foundations of the academies and universities, and sundry private foundations; while brief notices of a few international foundations—the Garton, Carnegie (Washington), Montefiore-Levi, Nobel, and seven of minor importance—are given.

As an index to facilities for advanced study and research the book serves as a useful supplement to the "Index Generalis" issued by the same publishers, and the "Universités et Ecoles Françaises." It might easily and advantageously be condensed to one-half its present size.

The Banana: Its Cultivation, Distribution, and Commercial Uses. By William Fawcett. Second and enlarged edition. Pp. xi+299. (London: Duckworth and Co., 1921.) 15*s.* net.

THE first edition of this book was reviewed in NATURE, vol. 93, p. 608, 1914. In the new issue the opportunity has been taken to bring up to date the account of the cause and treatment of the "Panama disease," which has resulted in great damage to the banana plantations in the American tropics and the West Indies. The original chapter on fungus diseases remains, and the new information is embodied in an appendix, in which an account is given of the present position of knowledge of the disease and its treatment, based upon the work of Brandes, whose results were published in 1919. The appendix appears to consist of a reprint of an article which was published in the West Indian *Agricultural News* last year. Brandes's investigations demonstrated beyond doubt that the fungus *Fusarium cubense*, for long assumed to be the cause of the disease, is in fact the organism concerned, and for excellent reasons he prefers to describe the disease as "banana wilt."

Mr. Fawcett's book remains the best account in English of the banana as an economic plant, and the new appendix adds to its completeness. The second edition appears opportunely at a time when increased attention is being given to banana cultivation, not only as a fruit crop, but as a source of material for the preparation of useful foodstuffs.

Zentralblatt für die gesamte Landwirtschaft mit Einschluss der Forst- und Teichwirtschaft, der Tier-Pathologie und -Medizin. Edited by Prof. Richard von der Heide and Robert Lewin. Erster Band. 1920. Pp. 524. (Leipzig: Gebrüder Borntraeger, n.d.) 90 marks.

THIS periodical gives abstracts from papers dealing with agricultural and allied subjects; it covers the whole of the German work and a certain amount of foreign work also. To some extent it covers the same ground as the "Jahresbericht über die Fortschritte auf dem Gesamtgebiete der Agrikultur-Chemie," and we think the editors would be well advised to avoid overlapping with that periodical, which already finds a place in most of our agricultural libraries. There is undoubtedly room for a good annual abstract for general agricultural papers, and if its scope could be so widened as to include other work besides that carried out in Germany it would serve a useful purpose.

The Story Book of the Fields. By J. H. Fabre. Pp. 271. (London: Hodder and Stoughton, Ltd., n.d.) 8*s.* 6*d.* net.

THE little volume under notice differs widely from the majority of the late M. Fabre's works. It covers virtually the ground that is usually associated with the term "nature-study," containing, as it does, a series of chapters dealing with the elements of plant physiology, their application in agriculture and horticulture, and such processes as grafting, layering, taking cuttings, and the germination of seeds. Sundry other matters, such as lime, plaster, ice, wine, are introduced here and there, and the result is a very readable whole, though it lacks the charm of personal observation and much of the poetry that characterises Fabre's insect studies.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Biological Terminology.

WHEN one is appealed to by name throughout two whole pages of NATURE (October 6) to answer various questions, it would be churlish to give no reply. But, now the holidays are over, Sir Archdall Reid must forgive me if I do not take up all his points. It is the more easy to escape gracefully, because one can refer him to the clear and thoughtful address of Prof. Goodrich to Section D of the British Association, which seems to put in more acceptable form the ideas that Sir Archdall is struggling to impress on us.

To confine myself to the sentence, "Variation is the sole cause of non-inheritance, etc.", Sir Archdall Reid accepts my description of it as an identical proposition, and admits that the words "the sole cause of" are redundant. The second part of his sentence I represent by "etc.," because I agree with him that it means the same as the first part. If Sir Archdall Reid asserts that these statements are also the same in meaning as the sentence, "apart from variations, offspring tend to recapitulate the parental development," we must accept his interpretation, merely pointing out that it has no great bearing on the alleged phenomenon usually known as recapitulation.

These matters being agreed on, I would ask what is gained by this laborious insistence on the statement that "variation" and "non-inheritance" are two words for the same thing? Surely the problem before us remains the old one: What is the cause of variation? In this question the words "the cause of" are *not* redundant. Suppose we accept the whole Mendelian apparatus of separate factors and regard each as a minute portion of a chromosome, admitting all the mechanism of their transmission as worked out by T. H. Morgan and his school, we have still to ascertain why and how one or more of these units should change. Is the change always sudden, and only the representation in the characters apparently gradual? Or may the change of the unit itself be gradual? Is the change produced solely by some action in the germ-cells, or may it be the result of a modification in the parental body? If the latter alternative be proved, can we explain the further apparent fact that the change in the factor or factors induces a change of character harmonising with the environmental modification?

These are a few of the questions that assail us, and I have tried to express them without using any of the terms to which Sir Archdall Reid objects. It is hopeless to answer them by speculation alone; we must learn how the mechanism works. Sir Archdall Reid is right in emphasising the need for crucial experiments, but, so far as I can see, my biological colleagues do not need the lesson. What we all should like would be some suggestions of practicable experiments or observations that would decide some of the questions exemplified above. But that, even Sir Archdall Reid must admit, would be something other than "biological terminology."

F. A. BATHER.

Wimbledon, October 16.

Indian Land Mollusca.

IN an undated letter, without address, published in NATURE of October 6, p. 180, under the title "Indian Land Mollusca," Dr. Annandale states that he wrote offering the loan of the material of the Indian Museum to help in the preparation of Mr. Gude's work on these molluscs. This is the first intimation that the author or the publisher or the editor of this volume has had of the offer. Dr. Annandale states definitely that the "offer was ignored or refused." It is impossible to ignore or refuse an offer which never arrived.

It is also impossible to make those who stayed at their work in India during the four years of the war realise the difficulties and straits under which we in Europe were living. Had Dr. Annandale been nearer the seat of the war he might, perhaps, have realised that a very large number of ships coming from India were sunk in the Mediterranean by submarines. It is not unlikely that the offer is still lying at the bottom of the sea in the hold of some sunken vessel.

A. E. SHIPLEY.

Christ's College Lodge, Cambridge,
October 15.

Safeguarding of Industries Act, 1921.

PROF. ARMSTRONG's letter in NATURE of October 24 conveys the impression that he has become suddenly aware of the potentialities for evil of the above Act in its present form. Protests have, however, appeared in the Press over the signatures of Sir Clifford Allbutt, Sir Ernest Rutherford, and Sir G. Sims Woodhead; and in the House of Commons Major Barnes and Mr. F. D. Acland attempted to have inserted in all applicable clauses exemptions for articles required for scientific research. In this action Major Barnes and Mr. Acland were guided by the expressed wishes of the National Union of Scientific Workers, which has also fought the clauses of the Dyestuffs (Import Regulation) Act, 1920, and the German Reparation (Recovery) Act, 1921, which penalised research in this country.

We agree that if we believe in our craft we must be militant in its protection, though we are not sure that scientific workers would get much shrift if they adopted the policy Prof. Armstrong advocates. We agree that as an expedient in the present state of the English Constitution a strongly worded and unanimously supported memorial to the Prime Minister might throw into welcome relief the unhappy plight of science, and we therefore invite Prof. Armstrong, and those in agreement with him, to support this union and the British Association of Chemists, the bodies which have taken the initiative in directing the attention of Parliament to the disastrous effect that the above measures will have on research unless they are speedily modified. They might help us also to back up Major Barnes in his efforts to get the promised committee for the investigation of complaints against the working of the Act appointed without further delay.

We suggest that Prof. Armstrong should add to his motion before the council of the Chemical Society the recommendation that that body should lend us their aid.

L. BAIRSTOW,
President.
A. G. CHURCH,
Secretary.

National Union of Scientific Workers,
25 Victoria Street, Westminster,
London S.W.1, October 25.

Aurora Borealis, Terrestrial Magnetic Disturbances, and Sun-spots.

In connection with the aurora borealis observed by Major Lockyer on September 28–29 (NATURE, October 6), there was a magnetic disturbance of considerable activity recorded at this observatory. It commenced at 12h., September 28. There were minor movements on the H magnet, D remaining quiet, until a more active phase of the disturbance commenced about 19h., September 28. The major movements on all three magnets, D, H, and V, took place between 1h. 36m. and 4h. 50m., September 29. The extreme ranges on the curves were D 30′, H 82γ, and V 85γ ($\gamma \equiv 10^{-5}$ C.G.S. units). The mean daily ranges, for comparison, for the quiet days of September were D 7′, H 36γ, and V 11γ.

The only spot on the sun on September 28–29 was of moderate size, in latitude +8·5 and longitude 56·0, and it was approaching the sun's western limb. But on September 28 the longitude of the central meridian of the sun was 354·1°. This gives the clue to the probable origin of the magnetic disturbance which accompanied the aurora, for the position is very near the longitude of the following spot of the great group of last May, namely, 358·8°, which on its passage across the sun's disc was connected with the series of magnetic disturbances of great violence. These, with a lull on May 18, persisted from May 12 to May 21. This spot-group was on the sun's equator, and also crossed the central meridian on May 14–15 (NATURE, June 2, p. 426).

It appears to be most likely that this region of the sun has remained magnetically active since the series of violent storms of May 12–21. For we get the following sequence of magnetic disturbances, at intervals of 27 or 28 days, corresponding to the period of the sun's synodic rotation :—May 12–21, v.v. great; June 6–10, great; July 7–9, moderate, August 3–5, great; September 2, v. great; and September 28–29, v. great.

The magnets have also been considerably disturbed on the early days of the present month of October, especially on October 5 and October 8. Meanwhile, the sun has been practically spotless. But here, again, with regard at least to the disturbance of October 5, there is a sequence of disturbances corresponding to the synodic rotation period of the sun, which probably has its origin in the later phases of the violent storm of May. The sequence is :—May 21, moderate; June 18, calm; July 15, moderate; August 11, moderate; September 8, great; and October 5, v. great. It will be noticed that in this sequence the magnets were quiet, and activity was in abeyance on June 18.

Since the violent storm of May there have been in all, until October 8, 28 moderate, 2 great, and 4 very great disturbances. All these disturbances, except four marked moderate, fall into four series corresponding to the synodical rotation of the sun, and of these, again, 12 moderate, 2 great, and 3 very great belong to the two series already discussed. It would, therefore, be premature to conclude, from the absence of sun-spots or other surface phenomena of the sun, when a magnetic disturbance occurs, that there is only a casual connection between sun-spots and terrestrial magnetic disturbance. An area on the sun may seemingly remain continuously or recurrently active for several solar rotations, even after the disappearance of the original solar disturbance. Or it may be that clouds of electrons discharged from a very active region on the sun remain undiffused for a considerable period. At the same time it is not evident why the magnetic activity should sometimes actually increase after a lull succeeding the original violent disturbance. Possibly spectro-heliograms in calcium light may help to elucidate the subject.

A. L. CORTIE.

Stonyhurst College Observatory, October 14.

Sex-change in the Native Oyster.

DR. ORTON's letter on the above subject published in NATURE of July 7, which I have just seen, touches a matter not only of great biological interest, but also of marked importance in the economy of oyster fisheries. I can confirm the presence of spermmorulæ in oysters which are functioning as "white-sick" females, and also the observation that on being placed in sea-water the sperms appear to be fully ripe. There are, however, a large number of oysters, apparently the majority, in any fair sample which may be examined at the breeding season which show no advanced female elements, but are functioning solely as males. These oysters, so far as I have been able to notice, do not show signs of any rapid sex-change.

When one reflects that oysters are naturally found in beds, and that fertilisation requires the free passage of sperms through the water to impregnate functioning females—if we are to discard Lacaze-Dutier's idea of self-fertilisation—it seems inevitable that there is an immensely greater loss amongst the male than amongst the female elements, and the presence of an excess of males seems explained. In the same way the development of active sperms in the gonads of oysters which are already bearing fertilised embryos in their mantle cavities may be a provision to further augment the supply of sperms. The annual breeding period—physical conditions being favourable—is spread over a considerable interval in this country. During the past summer, for instance, free-swimming spat could be found early in June, yet I found oysters with black spat on July 20, and "white-sick" oysters as late as August 26. In that period, it seems probable, from Dr. Orton's observations, that individual oysters may have functioned first as female and then as male shellfish. It would be very interesting to learn, however, if in the Plymouth observations any oysters functioning first as males showed any signs of ripening into females. The annual change of sex which Dr. Orton refers to as possible may be only in those oysters which are first predominantly female in sex.

W. L. CALDERWOOD.

Edinburgh, October 14.

A Relation between the Combined Atomic Volumes and their Optical Refractivities.

IT has been shown ("Monograph on Molecular Volumes," Longmans, 1917) that there is a periodic relationship between the atomic volumes of the combined elements. The submultiple 3·6, which is the atomic volume of combined hydrogen, has been found significant.

Table of Atomic Volumes.

	C	Δ	N	Δ	O	Δ	F	Mean
	14·8	(2·8)	12·0	(4·6)	7·4		6·5	3·7
Δ	15·2		15·0		16·1		15·1	
	Si		P		S		Cl	
	30·0		27·0		23·5		21·6	
Δ							7·4	
							Br	
							29·0	
							8·0	
							I	
							37·0	

I, N, and S, mean values.

The atomic volume ratios from solids are F=2S, Cl=6S, Br=8S, and I=12S. The differences now agree with those of the atomic refractions

(1) There is a decrease in the atomic volume from carbon to fluorine, silicon to chlorine—that is, against increasing atomic weight.

(2) The differences between successive members of the same series are equal to the volume of hydrogen (an approximation).

(3) The difference between the volumes of successive homologues is $n \times 3{\cdot}6$.

n is 4 between series 1 and 2.
n is 2 ,, ,, 2 and 3.
n is 2 ,, ,, 3 and 4.

If the masses be compared, there is a difference of 2 in the first series and $\Delta n = 16$ (4×4), 44, and 47 respectively between groups 2 to 1, 3 to 2, and 4 to 3. It follows that there is a concentration of matter from within to without, or that members of the first and second series are less condensed than those of succeeding series.

There is also a difference of 3·7 between alternative values of a single element :—O 11 and 7·4, Δ 3·6, S 25·0 and 21·6, 3·4, and so on.

The volumes thus indicate that the elements are built up from discrete parts which are similar for all the elements. The indication is, of course, not exceptionally clear, but it is very pronounced. This is not surprising, seeing that liquids are subject to so many different influences.

If A.V.'s be plotted against A.M.'s, paraboloid curves are formed (*a*) at 6·1, in solid state, (*b*) at absolute zero $b \times 10^5$. Note especially the rare gases Ne 76, Ar 144, Kr 177, Xe 228–251, Nit 287 (*cf.* R. N. Pease, Journ. Amer. Chem. Soc., May, 1921).

A periodic relationship also exists between the atomic refractions. Traube was the first to indicate a valency relationship, but in a very imperfect manner.

Table of Atomic Refractivities.

C	Δ	N	Δ	O	Δ	F
3·36	(0·98)	2·38	(0·90)	1·48	(0·81)	0·67
		5·38		5·31		5·29
Si		P		S		Cl
8·80	(1·04)	7·76	(0·97)	6·79	(0·83)	5·96
				(7·76)		
		2·74				2·73
		As		Se		Br
		10·50		(10·86)	1·10	8·79
				9·89		
						5·08
						I
						13·87

Similar serial and group relationships are noticed in the atomic refractions as in the atomic volumes. First, successive differences of from 0·81 to 1·04 are noticed from element to element in the different series, and this corresponds to the atomic refractivity of hydrogen, or, showing a rough proportionality to their respective valencies, C 3·36 (4×0·84), N 2·36 (3×0·79), O 1·48 (2×0·74), F 1×0·67, Ne 0. The atomic refractivities, however, differ considerably in different circumstances.

The differences between the values for homologues are again a considerable multiple of the unit—$n=4$ (4×1·33) between the first and second groups, 2 (2×1·34) between the second and third groups, and again 4 (4×1·27) between the third and fourth groups. The unit is, however, larger in the group differences than in the serial (0·81 to 1·06). We know that there is justification for these multiples from observations on atomic degradation phenomena. Dividing by 8 the ratio is equal to 0·67, which is similar to the valency value.

A relation can be found between the atomic refractions for members of the two short series if the number of helium (2) *plus* latent valency electrons be added to the number of *acting* valencies.

$r_a(E_1) = (He + L.V.) \times 0 + n(F.V.) \times 0{\cdot}74$
$r_a(C) = 3$ approx. $N_C = 2+0+4 = 6$ A.N. = 6
$r_a(F) = 0{\cdot}74$ $N_F = 2+6+1 = 9$ A.N. = 9
$r_a(E_1) = (He + L.V.) \times 0 + 8 \times 0{\cdot}67 + n(F.V.) \times 0{\cdot}74$
$r_a(Cl) = 6$ $N_{Cl} = 2+6+8+1 = 17$ A.N. = 17
$r_a(P) = 7{\cdot}58$ $N_P = 2+2+8+3 = 15$ A.N. = 15
$r_a(Br) = 8{\cdot}78$ $N_{Br} = 2+6+12+1 = 21$
$r_a(As) = 7{\cdot}58$ $N_{As} = 2+2+12+3 = 19$

It is evident that the numbers for members of the third series fall short of the atomic numbers.

Mn. A.N. 25 N_{Br}21 Δ4
V A.N. 23 N_{As}19 Δ4
Br. A.N. 35 N_{Br}21 Δ14, or 12, if members of the eighth group number only one (isotopes).
As. A.N. 33 N_{As}19 Δ14.

From this it follows that a larger nucleus of the members of the longer series becomes impermeable to light, the number being much greater for even series of period 3. These considerations point to the fact that some central condition produces a repelling power on light-waves of moderate length and speed, whilst, on the other hand, the electrical rather than the material elements tend to retard the light.

It is thus seen that there is a clear and distinct connection between the atomic volumes, the atomic refractions, the make-up of the elements, and also their evolution from sub-atomic discrete electrified particles.

The accompanying curve (Fig. 1) shows the nature of the relationship in a general way, and this is approximately rectilinear.

Expressed numerically, this becomes

$$\frac{V^1 - V}{R^1_a - R^F} = 2{\cdot}58$$

also

$$\frac{15{\cdot}0}{5{\cdot}3} = 2{\cdot}8 .$$

The differences $\frac{\Delta V}{\Delta r_a}$ between series are 2·8, 2·7, and 1·2 respectively, the latter being small because $n=1$ for one property and 2 for the other.

The relation $\frac{\Delta V}{\Delta r_a}$ is equal to 4 between successive groups.

The light-waves from the evidence of optical refractivities appear to pass chiefly through the gaps between the atoms A | B | C | D, as through a grating encountering the valency electrons which tend to retard them. Only single rings of electrons in the first series are affected by the light-waves, the nuclei not being affected. This is shown by the diminishing refractivities with the increase of atomic masses in the regions of the periodic system under examination. In the second and subsequent series a shell of electrons (several rings) is influenced.—a similar kernel not being affected. Any influence which causes the electrons to be drawn more into paths of light (unsaturation) results in an increase of the refractivity.

If the electrons be supposed to be distributed in space, according to principles of equal distribution in the same atom,[1] with, perhaps, constraining disturb-

[1] Octahedral models for rare gases (spheres).

ances in position in some combinations, it is probable that a definite and approximately equal share of space must be accorded to each electron. The approximately rectilinear curve points to this fact. Both properties, however, differ somewhat in different combinations, so that some slight modification is to be understood. It is, however, sufficiently interesting to be able to trace such a relation when it is considered that neither the atomic volumes nor refractions can be directly measured, but are derived constants.

Some of the variations seem to point to variable relations with the ethereal medium. Negative anomalies, for example, are at present incomprehensible, the whole of the atomic refractions of, say, oxygen in $P(OEt)_3$, for example, disappearing entirely. Some of the *per saltum* changes are equally difficult to explain. The periodic relationship between the elements points rather to a spiral arrangement (understood in a solid sense)[2] of the electrons than to a series of rings. This arrangement is due to the fact that the spiral is one of the natural modes of motion of the æther and discrete particles immersed in it.

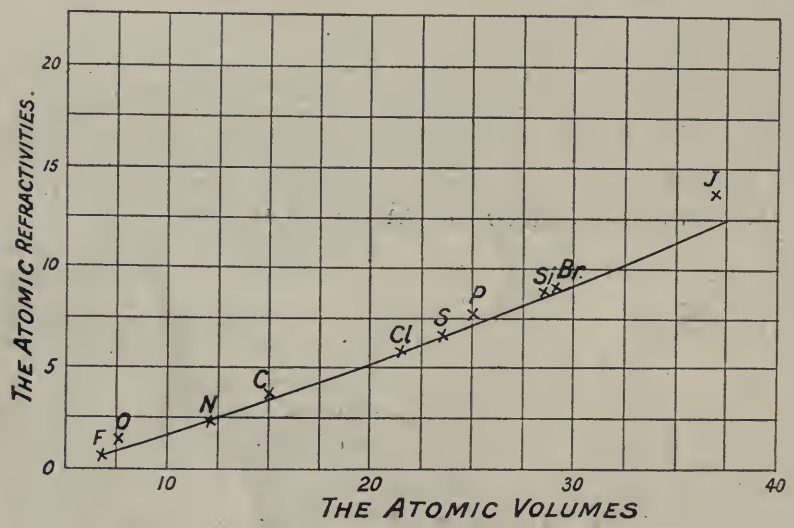

FIG. 1.—A relation between the atomic volumes and the atomic refractivities.

This is shown in the case of spiral nebulæ. The vortex is another condition. Gradual disintegration of the atoms is thus more easily understood, and devolution is reversed evolution.

Up to the present the charge on the electron is regarded as static, but the existence of magnetic properties suggests rotations of electricity on the material particles. This would result in a magnetic flux. It, however, seems to be impossible to distinguish the charges within the atom.

Note.—A numerical relation with the atomic masses suggests itself. $m = 3r_a \times F$, F being a factor probably representing concentration of matter (atomic density).

$m = b_0 \times F$ b_0 for A.Z.

$\frac{m}{b_0} = F(2, 2, 3, 3)$ not for first series except for C.

Cl	$6 \times 3 \times 2 =$	36
Mn	$8{\cdot}8 \times 3 \times 2 =$	52·8 (55)
Br	$8{\cdot}8 \times 3 \times 3 =$	79·2 (79·6)
I	$13{\cdot}9 \times 3 \times 3 =$	125·1 (126).

F. diminishes from group 7 to 4 and increases differently in the groups. This relation is, however, based on products, whilst the additive cumulative factor is evident; still, the relation is interesting. The next homologue after Cl is Br (red liquid). There is, however, a large gap between the two. Instead of an easily condensible yellow-red vapour at 55, by some twist we get a metal. There is a similar disparity between Br and I.

GERVAISE LE BAS.

6 Springfield Crescent, St. Heliers, Jersey.

[2] A spherical *tourbouillon* with a vortical centre and a peripheral rotation (model slip-knot).

Hybridity and the Evolution of Species.

As the author of the "Theory of Evolution by Means of Hybridisation," I am naturally much interested in the recent papers by Dr. Harrison and Miss Blackburn, which proved beyond any reasonable doubt that most British rose-species are of hybrid origin, though this was not suspected. The authors based their conclusion that hybridity is one of the prime factors in the evolution of species, if not the only one, on their cytological results, which agree with those of Tackholm on a much larger number of rose-species from all parts of the world. The reviewer of their papers in NATURE of September 15, p. 99, does full justice to the importance of these results, and directs attention to Jeffrey's work tending to show that the presence of "bad pollen" is proof of a hybrid origin—a view much strengthened by Brainerd and Petersen's study of the New England *Rubi* (Vermont Agric. Expt. Sta. Bull. No. 217), in the course of which they find much hybridisation and no forms with entirely good pollen.

To this view the reviewer takes exception. That "bad pollen" is unsafe as a criterion of hybridity is shown, he says, however, by other results. As such he considers the fact that isolated species, such as the Californian *Trillium giganteum*, the nearest relative of which is in the Eastern States, possess a certain amount of bad pollen. I am sorry to say that I fail to see the bearing of a now isolated habitat on the problem in question. I suppose that the reviewer will agree with me that the origin of *Oenothera biennis*, which for several centuries has been a feature of the flora of the dunes in many European countries originated elsewhere than in Europe; so why should *Trillium giganteum*, and *Dirca occidentalis* and *Scoliopus Bigelovii*, the other two species with bad pollen which he quotes as proof of his contention, have originated at the spots they now occupy? And if they originated somewhere else, the argument against their possible origin by crossing does not hold good.

Velp, Holland, October 4. J. P. LOTSY.

IT is perhaps only natural that Dr. Lotsy should take a special view of any facts that bear on his theory of evolution by hybridisation, but in the above letter he is clearly begging the question. In the article on British roses and hybridity to which he refers it was pointed out that the original authors did not consider *all* British roses to be hybrids, but looked upon the diploid forms and the Pimpinellifoliæ as pure species. In such cases as Trillium, Dirca, and Scoliopus, it is not sufficient for him to suggest that they must be hybrids merely because they have bad pollen. The fact, previously cited, that

pollen sterility and fertility behave as a pair of characters in the sweet pea and the velvet bean should in itself be sufficient to give pause to those who would like to regard bad pollen as a proof of hybridity. The theory of mutation equally requires the occurrence of a certain proportion of defective germ cells.

The Hagedoorns, in their recent book on "The Relative Value of the Processes Causing Evolution," also support the idea of the origin of species by crossing, but are obliged to admit that loss mutations must occur, though why they should confine themselves to loss mutations is not clear. It will be necessary to bring some more convincing argument in support of hybridisation as a constructive evolutionary factor before it is likely to receive much serious consideration from biologists.

THE WRITER OF THE ARTICLE.

A System of Space-Time Co-ordinates.

THE common instruments of measurement proposed in theory and employed in practice for the co-ordination of physical events consist of rigid bars and clocks. The limitations of such methods are obvious. The erection of a rigid bar for the direct determination of the distance of the moon from the earth is inconceivable from a practical point of view, while it is a gross absurdity to speak of the measurement of molecular distances by means of rigid bodies. There is only one type of connecting-link across space suitable for co-ordination of events, namely, the light-ray. I here define a system of space-time co-ordinates which involve only one metrical quantity, the vibration period of an atom.

Let there be a vibrating atom at A emitting light-rays. The *time* at A is read from the atom there. Let P be any other particle, which sends back instantaneously to A the light-rays arriving from A. Let a ray start from A at time t' and return to A at time t''. If an event occurs at P at the instant of the arrival of the said ray, we shall define two of the co-ordinates of the event as

$$\textit{distance of event from } A = x_1 = \tfrac{1}{2}(t''-t'),$$
$$\textit{time of event} = x_4 = \tfrac{1}{2}(t''+t'),$$

the expressions in italics being defined by these statements.

Let B and C be two particles such that x_1 is constant with respect to time for each of them. Let a light-ray be emitted from B and return to B after reflection from C. The departure from B and return to B of this ray are two events at B, and we have already defined the time of events occurring at B. Let the ray leave B at time x'_4 and return to B at time x''_4. Let C be so situated that $(x''_4 - x'_4)$ is constant for all successive rays.

A, B, and C constitute the frame of co-ordinates. For sake of example, we may observe that three of the corners of a rigid rectangular block at rest in a terrestrial laboratory satisfy the conditions imposed on A, B, and C, so far as our experimental accuracy can ascertain; whether they would continue to do so if the block was rapidly revolved about an axis is a matter for experiment to decide.

We have now three particles, A, B, and C, and from our definitions we can write down the time of an event occurring at any of the three. Let any event P occur. Let it coincide with the arrival of a light-ray from A which left A at t'_A and returns to A at t''_A and with the arrival of a ray from B which left B a t'_B and returns to B at t''_B, and also with the arrival o a ray from C which left C at t'_C and returns to C at t''_C. We define the four co-ordinates of the event P by the equations:—

$$x_1 = \tfrac{1}{2}(t''_A - t'_A)$$
$$x_2 = \tfrac{1}{2}(t''_B - t'_B)$$
$$x_3 = \tfrac{1}{2}(t''_C - t'_C)$$
$$x_4 = \tfrac{1}{2}(t''_A + t'_A).$$

It is to be observed that this co-ordinate system, although from the method of definition applicable to the most general gravitational fields, will, in the absence of such fields, give the same values for the co-ordinates of an event as those obtained by rigid body measurements from three points of a rigid body and by a system of clocks.

J. L. SYNGE.
Department of Mathematics, University of Toronto, Toronto, Canada, September 16.

Aeroplane Photography for Archæology.

PHOTOGRAPHS from an aeroplane taken on a clear afternoon a little before sunset would give good records of ancient British and Roman camps, "castles," villages, rings, pack-tracks, barrows, ditches, and other earthworks, and, as in such photographs taken in Mesopotamia, would probably reveal details that cannot be distinguished by inspection on the ground. Photographs might yield almost as much information as the models in the Pitt Rivers Museum at Farnham, which were made from laborious contour surveying.

There are hundreds of such earthworks on Salisbury Plain, and many of them are, no doubt, related to Stonehenge and to Avebury. The stereoscopic combination of two successive photographs might disclose those parts of the banks and ditches which are nearly obliterated by the village of Avebury. General modelling is wanted rather than fine detail. Perhaps such work might be done by learners.

A. P. TROTTER.
Greystones, Teffont, Salisbury, October 12.

Cosmic Friction: A Query.

WRITING with proper deference, I would ask astronomers whether it is not feasible to consider that the solar system may occasionally journey through a region of space occupied by exceedingly diffuse matter? Under such conditions the exceptional appearance of a large meteorite outside the earth's atmosphere might be possible; and some minute shortening of the period of a quickly revolving satellite, like the moon, might show itself by a cumulative advance of position. Contrariwise, if ever (say between 1865 and 1871) we passed through regions altogether free from even such evanescent friction, a readily affected comet, like Encke's, might temporarily recover from its usual perturbation.

OLIVER LODGE.

Muscular Piezo-electricity?

THERE is a remarkable similarity between the structure of those organs of electric eels which are generally held to be the source of their "shocks" and the structure of certain artificially grown crystals exhibiting the piezo-electric property. Is it possible that there is a connection between the two, and that these creatures do produce piezo-electricity by the contraction of these organs? I should be interested to know if any of your readers have found any connection between these two phenomena.

E. WRIOTHESLEY RUSSELL.
Trinity College, Cambridge, October 10.

Speaking Films.

By PROF. A. O. RANKINE.

THE publicity recently given (*Times*, September 24 and 28) to reports of the successful synchronisation of speech and action in kinematography makes the present an appropriate time for describing the production and use of photographic films bearing sound-records which are reproducible. For the novelty of the recent inventions does not lie in the speaking films themselves, but in their combination with picture films so as to constitute the so-called "talking pictures." It was about the year 1900 that Ernst Walter Rühmer made the first speaking film. The process is described in his book on "Wireless Telephony," translated into English by J. Erskine Murray in 1908. Rühmer's invention was the natural outcome of his work on photo-telephony, the principles of which are treated in the same work. In photo-telephony there are imposed upon a projected beam of light fluctuations of intensity which correspond to the sound-vibrations associated with speech; for purposes of reproduction the light is allowed to fall upon a selenium [1] cell, which, by its well-known photo-electric property, controls the current in a telephonic circuit. It was a simple modification to carry out the process in two distinct stages, viz., (1) to photograph the fluctuations of the light upon a moving film, and (2) to actuate the selenium cell at leisure by interposing between it and a source of light, the developed film moving at the same speed as before. For this device Rühmer chose the descriptive but ugly name "photographophone," and printed reproductions of some of the films obtained by him appear in that chapter of his book which bears this name.

Rühmer's method of obtaining the fluctuations of light corresponding to speech was to superimpose upon the current in an electric arc variations due to a microphone actuated by the voice. This method has been used by several later investigators, including H. Thirring (*Phys. Zeit.*, p. 67, 1920), who has also devised a particularly sensitive form of selenium cell. The chief difficulty in connection therewith appears to be that of keeping the arc in a sufficiently sensitive condition. In an entirely different method, due to the author, described in NATURE for February 5, 1920 (vol. 104, p. 604), under the title "Telephoning by Light," [2] this difficulty does not present itself, and a fluctuating beam of light with the necessary characteristics is obtained with ease. Its application to the production of speaking films has already been indicated (Proc. Phys. Soc., vol 32, p. 78, 1920), but many new records have been obtained since the date of that publication.

The mode of recording adopted, which differs in no essential respect from Rühmer's, is to allow the fluctuating beam of light emerging from the photophone transmitter to fall upon a condensing lens, L_1 (Fig. 1), so that an image of the original source of light is formed at S. A narrow, horizontal slit thus illuminated at S serves as a secondary source, and the lens L_2 brings an image of it to a focus upon a continuously moving photographic film suitably enclosed. A slightly different arrangement, which is superior optically, is to place a larger slit close to, and extending over the full aperture of, the lens L_1, and to obtain on the film a suitably diminished image of the slit by giving the lens L_2 the appropriate focal length. By providing in addition that the focal length of L_1 is equal to the distance L_1L_2, the image of the original source, usually quite small, coincides with L_2, of which the central region only is thus used, and aberration is much reduced. It will be seen that the moving film is exposed to

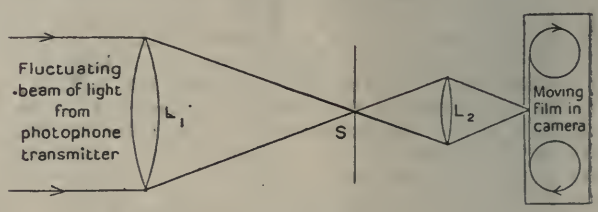

FIG. 1.

a narrow bar of light, perpendicular to the direction of motion, of which the intensity is varying in accordance with those sounds which have actuated the photophone beam. The result is that the film, when developed, shows a band varying in opacity as the length is traversed, and looking very much like a discontinuous spectrum. Two examples (reduced by one-fourth) are shown in Fig. 2—the records of the words "beet" and "this" respectively. They have been chosen because they are short, staccato words capable of being reproduced in the space available. The beginning of each word is at the top, and the speed of the film was about 1·3 metres per second. The amount of detail shown in these records depends, of course, upon the relation between the width of the slit image on the film and the film velocity. For those shown the slit image was about 0·2 mm. wide, so that frequencies of several thousand per second, if present, should be visually detectable.

The procedure for reproducing the sounds from the films is very simple. All that is needed is to

[1] Selenium is not the only substance suitable for this purpose. Other photo-electric cells have been constructed during recent years, notably the "thalofide cell" of T. W. Case and the "antimonite cell" due to W. S. Gripenberg. The sensitive substances here involved are sulphides of thallium and antimony respectively. The relative merits of such cells are open to question, and require careful experimental investigation; but they do not affect at all the principles of sound-reproduction from photographic films as described in this article.

[2] The article here referred to should be read in conjunction with the present one.

focus the light from a narrow source upon the film, and to allow the light which penetrates the

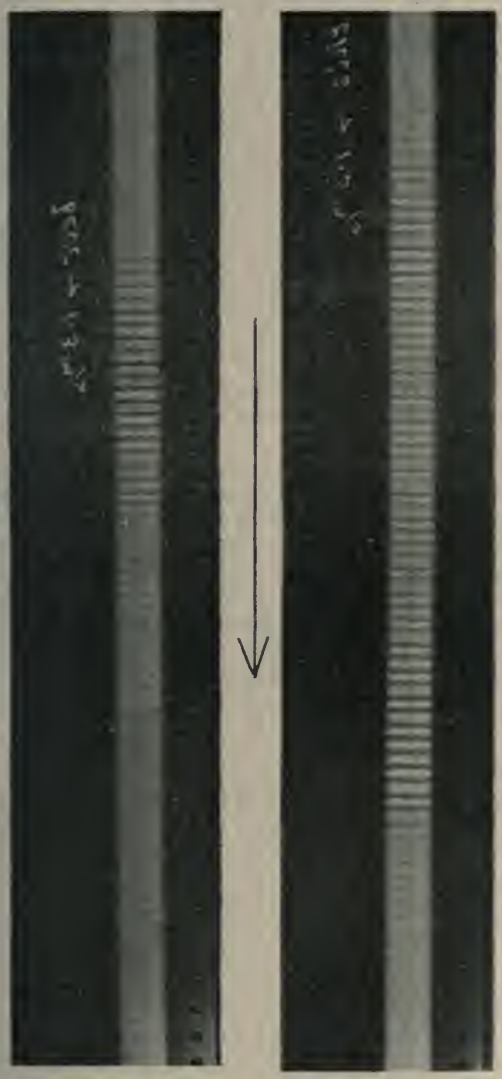

FIG. 2.

film to fall upon a selenium cell connected with a battery and telephone receiver. For example, the arrangement shown in Fig. 3 works satisfactorily. Here the slit S is illuminated by the condensed light from the arc, and its image is formed on the moving film at F. The light reaching the selenium cell, upon which, if necessary, it can be concentrated by an additional lens, is caused to fluctuate as the film moves, so that the corresponding sounds are heard in the telephone. It is usually necessary to amplify the feeble telephone currents by means of one or more thermionic valves. Mr. Bergland, the Swedish inventor whose recent kinematograph work elicited this article, has apparently been able to attain augmentation sufficient to actuate effectively loud-speaking telephones so as to be audible throughout a room; but the number of valves used in cascade has not been announced.

There are certain somewhat remarkable features in connection with the sound reproduction from films such as those illustrated. These, although already enumerated (*loc. cit.*), are worth emphasising. Strictly, in order that the sound-vibrations reproduced may correspond exactly to those which originally controlled the beam of light and gave the photographic record, the speed of the film should be the same during recording as during reproducing; but the ear and brain are apparently capable of recognising a word even though the frequencies associated with its utterance have been altered in constant proportion to a considerable degree. This applies more to some words than to others, but, generally speaking, precise equality of film speeds in recording and reproducing is not necessary, nor does there prove to be any need to take particular care to secure the correct photographic density; the articulation of the reproduced sounds is wonderfully good without this elaboration. Most remarkable of all, however, is the small effect arising from widening the slit image used during reproduction. It has been found that this image may be made several times wider than when recording without marked deterioration of the reproduced words. All this points to the fact that effective listening demands only the existence of the chief features of the complicated vibrations constituting speech sounds. The practical effect is that in gramophones generally the speed used need not be so large as to record all the finer details existing in the vibrations, and in the case of the particular *optical* gramophone under consideration, a film speed much less than that indicated above would suffice. Experiment proves this to be true, and successful films have been made, as was anticipated, with speeds of about 40 cm. per second (the approximate rate in the kinematograph as ordinarily used) and a slit image 0·2 mm. wide. The degree of success in reproduction may be judged from the fact that single words, isolated from all context, are nearly always recognised at once, in spite of the severe test which such an arrangement obviously imposes.

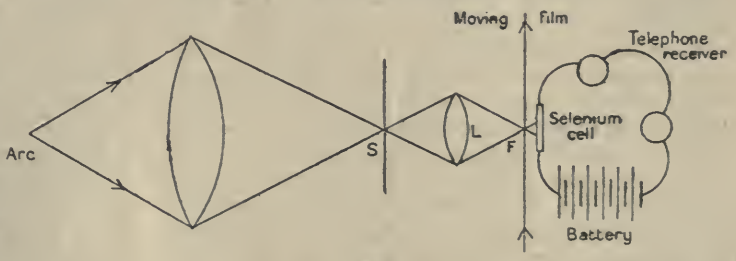

FIG. 3.

In passing from the consideration of speaking films alone to their synchronous combination with kinematograph pictures, we pass from facts well

established scientifically to information at present only obtainable in newspaper reports. Emphasis need not be laid on the obvious advantages of a *film* sound-record over an ordinary mechanically produced gramophone record. Combinations of picture films and ordinary gramophones have been frequently tried without success sufficient to ensure their survival in practice. The difficulty, of course, mainly arises from the impossibility of *preserving* synchronism between a gramophone record and a film the length of which is gradually but inevitably shortened by the repairing of frequent breakages. With the sound-record *also* upon a film, the appropriate adjustment can always be made, especially in the ideal case where a single film bears both picture- and sound-records, side by side, under which conditions it becomes automatic. The arrangement of two separate films, run both in recording and reproducing on the same shaft, has, according to the *Times* report, been adopted by Mr. Bergland; Mr. Grindell Matthews, on the other hand, announces that he has been able, in spite of the small space available, to secure the advantages of a single film, a newspaper reproduction of which is given. In neither case are the reported details complete enough to indicate the actual mechanism employed. One point of somewhat curious interest seems, however, to be fairly definitely established. An examination of the printed reproduction of Mr. Grindell Matthews's film shows that the sound-record is of what may be called the *ordinary* type —*i.e.* it consists of the trace of *transverse* movements of a spot of light on a moving film, so familiar in oscillograph and other wave-motion records. A talk which the author was fortunate enough to have recently with Prof. Arrhenius, who was present at the first demonstration of the new Swedish talking pictures, made it clear that Mr. Bergland also relies on this same plan. It is not easy to see how such transverse records lend themselves to effective sound-reproduction. On the face of it, they would appear to be distinctly inferior for this purpose to the records described and illustrated in this article, and details of the manner in which the selenium is actuated will be awaited with interest.

We have yet to learn also by what mechanism synchronisation has been effected. For, although the principle involved is very simple, and the general method of procedure is quite obvious, there have no doubt arisen in practice details which present serious difficulties. We may hope to hear before long what these are and how they have been surmounted.

The Oppau Explosion.

THE directors of the Badische Anilin- und Sodafabrik state in the *Zeitschrift für Angewandte Chemie* for October 4 that the explosion at the nitrogen fixation works at Oppau on September 21 took place in a store containing about 4500 tons of ammonium sulphate nitrate. They explain that, before the war, only sulphate of ammonia was made at Oppau; ammonium nitrate was manufactured during the war, and since then, mixtures of ammonium nitrate and potassium chloride, and more recently ammonium nitrate and sulphate for use as fertilisers. They definitely state that no ammonium nitrate was present in the works at Oppau at the time of the explosion, and go on to say that while the explosive nature of ammonium nitrate is well known, this feature can be completely eliminated by mixing it with potassium or sodium chlorides; the double salt, $2NH_4NO_3 \cdot (NH_4)_2SO_4$, had also been shown to be non-explosive when pure as well as when it is produced on the works scale. They proceed to quote evidence as to the non-explosive character of this salt from the fact that it gives no distension in the Trauzl block test, when exploded by means of a detonator containing 2 grams of mercury fulminate, and in substantiation of its innocuous character they adduce the fact that in factories producing it no accident has occurred for a number of years, when explosives have been applied to it for the purpose of breaking up blocks of the mixed salts which have set hard. They deny that Oppau was completely destroyed, and say that the portion of the factory devoted to the production of ammonia from the air and of ammonium sulphate is comparatively uninjured, so that the manufacture could be started again, and they end with an assurance that the production of ammonia by high pressure as carried out by the Badische Anilin- und Sodafabrik has nothing whatever to do with the explosion.

It may be remarked in connection with this statement that no reference is made to experimental work on the explosive character of their product on a larger scale than by attempting to fire it by a No. 8 detonator in a Trauzl block. It is known, however, to explosive technologists that ammonium nitrate responds only feebly to such a detonator, but that it can be brought up to detonation by a suitably chosen initial impulse.

The *Times* of October 12 gives an account of some very remarkable evidence brought out at a sitting of the German Parliamentary Committee appointed by the Reichstag to inquire into the explosion. It appears from the evidence that the process was being worked intensively and without adequate chemical control, and it is stated that in the preparation of the ammonium sulphate nitrate the ammonium nitrate was not always dissolved, but passed on to the store as such. Evidence was also given as to the fact that blasting was resorted to for the purpose of breaking up the hardened mass, and in a further report, published in the

Times of October 17, it is stated that this blasting was sub-let to a firm of contractors and was done by men on piece-work.

There appear to be at least three commissions investigating the accident: one, appointed by the Reichstag, another by the Bavarian Government, and a third by the Workmen's Council of the Oppau factory, and it is gathered that there is some conflict as to the powers and status of these commissions. An adjournment of the inquiry has evidently been made, but it is not clear as to whether this is for the purpose of obtaining further evidence on the danger of blasting, or, as is suggested by the writer of an article in the *Chemiker-Zeitung* of October 6, on danger that may arise from heating up of the mass through the liberation of nitric acid from ammonium nitrate by the acid held as an impurity in the ammonium sulphate. With regard to the latter point, it is stated that the representatives of the factory are taking a continuous record of the temperature of the remaining stock, which amounts to 8,000 tons, with the object of flooding it if any considerable rise occurs.

In view of the importance of ammonium nitrate and other salts of ammonia for fertiliser purposes on the very largest scale, it is to be sincerely hoped that every endeavour will be made by the Inter-Allied Commission of Control to obtain the final report of the German Parliamentary Committee, together with a record of any experiments conducted to elucidate the cause of the explosion.

The Age of the Earth.[1]

By the RIGHT HON. LORD RAYLEIGH, F.R.S.

THE subject which we have met to consider to-day is encumbered with past controversy. It cannot be denied, I am afraid, that exponents of particular views in the past have laid too much emphasis on their own particular way of looking at the problem without making enough allowance for human fallibility. I shall try, so far as possible, to avoid this pitfall. There has been a tendency on all sides for specialists in one branch of science to consider themselves free to disregard evidence drawn from a class of considerations with which they are not familiar. I am sure that this is not the road to truth. In attempting a problem of this kind, when we seek to plumb into the depths of time, far beyond human experience, we cannot afford to neglect evidence drawn from any quarter, even if it is not the kind of evidence which we find it most congenial to contemplate. A parallel case is that of a jury of plain men in a murder trial. They may know nothing of medical jurisprudence, post-mortem examinations, and so on. They may even consider the subject repellent; but that does not exempt them from the duty of fully considering and weighing such evidence to the best of their ability. The witnesses in the trial have, however, to limit themselves to matters with which they are personally conversant. I will try to give my evidence within these limits.

The phrase "age of the earth," though rather vague, is perhaps definite enough for our purpose. What we want to know is, how long has the earth's surface been fitted for the habitation of living beings? or, alternatively, how long has it taken to accumulate the known series of geological formations? These questions are not the same, but I do not think that we shall need to insist on the distinction this morning.

Lord Kelvin's arguments depended on attempts to limit the length of time during which the earth's surface temperature could have remained substantially the same as at present, and he attacked this problem from two different points of view. In the first place, he attempted to set a limit of time to the duration of the sun's heat; and secondly, from consideration of the earth's internal heat, he argued back to the time when the surface was too hot for the presence of living beings. I have heard a suggestion that there is some mutual inconsistency in these two lines of argument—consideration of the sun's heat makes the past temperature too low; consideration of the earth's heat makes it too high—but I do not think that this criticism is more than superficially plausible. The point was rather that from either of these arguments a condition widely different from the present would be reached, and therefore that, even if there were some unrecognised flaw in one of the arguments, the other would stand. Possibly, looking back into the remote past, a condition of the earth's surface is imaginable where the mean temperature was much the same as at present, heat coming from the earth's interior in compensation for a diminished radiation from the sun; but I feel sure you will all agree with me that we cannot get more time by special pleading of this kind. The fossiliferous rocks have, without doubt, been accumulated under conditions of solar radiation not essentially different from the present. One simple consideration is that the plants in the coal measures obviously had green leaves, and that these could not function without a full allowance of solar radiation.

We have then to consider whether Lord Kelvin's arguments can stand in the light of present knowledge. I think we must admit that they cannot.

First, as regards the earth's heat, it is now generally known that the premises of Lord Kelvin's calculation, carefully particularised by him, are upset by the discovery of radio-active substances in the earth. In 1906 I made a deter-

[1] Contributions to a joint discussion of the Sections of Mathematical and Physical Science, Geology, Zoology, and Botany of the British Association at Edinburgh on September 13.

mination of the amount of radium in the superficial parts of the earth which are alone accessible. From radium analysis we can calculate the amount of uranium and other associated substances and the thermal output from them, and the result is to show that if we suppose the same radium content to extend to a depth of some 20 miles, the whole output of heat would be accounted for without assuming that any of it comes from the store of primeval heat as postulated by Lord Kelvin. It is without doubt difficult to understand why the output of heat is not greater, for it would certainly be expected that the rocky crust of the earth would be more than 20 miles thick, to say nothing of any radium there might be in the unknown interior.

Can we at present infer anything definite from the earth's internal heat as to the possible duration of geological time? I think practically not. It appears certain that the radio-active materials present in the earth are generating at least as much heat as is now leaking out from the earth into space. If they are generating more than this (and there is evidence to suggest that they are), the temperature must, according to all received views, be rising. In a word, we are puzzled to explain the existing state of things, and cannot use it as a firm basis from which to explore the past.

Next, as to the sun's heat. Lord Kelvin's argument was that we knew of no possible source at all adequate to supply the existing output of solar energy except secular contraction, and even this source of supply was not enough to account for more than twenty million years of solar heat in the past. It is impossible to condemn on principle arguments of this kind. We often must, and do, rely on them in science as in everyday affairs; but a certain reserve is always needed on the ground that there are more things in heaven and earth than are dreamt of in our philosophy. Knowledge which has accumulated since Lord Kelvin's time has driven us back on this alternative.

The sun is only one of the host of stars, and if we find it impossible to account adequately for their radiation by contraction it evidently will not do to assume that the sun is limited to this source of supply.

Now some of the stars (the giant red stars), though of about the same mass as the sun, are radiating energy at something like one thousand times the rate that the sun does. They ought, according to the contraction theory, to have expended a considerable fraction of their total energy in historical times. No one will maintain that this has occurred, and if not there must be some source of supply other than contraction. It is not necessary for our immediate purpose to inquire what this source is. It is enough to note that its existence invalidates Lord Kelvin's estimate of the age of the sun's heat.

Modern knowledge in radio-activity has given what appears, if separately considered, to be a firm and satisfactory basis for the estimation of geological time. Uranium, for example, goes through a series of changes (radium is one of the stages in its progress), changing eventually into an isotope of lead—that is, an element chemically indistinguishable from lead, except by a slight difference of atomic weight and (practically at least) inseparable from ordinary lead by chemical means if once mixed with it. The isotope of lead in question has probably an atomic weight of 206 exactly, as contrasted with an atomic weight of 207·1 for ordinary lead.[2] This is much less than the atomic weight of uranium (238·5), and the difference represents approximately the weight of helium atoms, which are the debris shed at the various stages of the transformation.

Further, it is well established that a gram of uranium as found along with its products in rocks and minerals is now changing at a rate represented by the production of $1{\cdot}88 \times 10^{-11}$ grams of helium and $1{\cdot}22 \times 10^{-10}$ grams of lead isotope per annum. We have not time this morning to consider the methods by which these figures have been reached. It must suffice to say that in the case of helium it amounts practically to direct observation, while in the case of lead isotope the evidence, though less direct, is very strong, and, so far as I am aware, is not contested by any student of the subject. I have said that this is the rate at which one gram of uranium as found in the earth is producing helium and lead isotope at present. It is important to inquire whether one gram of uranium did the same in the past. This we cannot, of course, determine directly. It is certain that nothing we can do in a laboratory in the way of change of temperature and pressure can alter the rate sensibly, and enough has been done in this way to make it unlikely that any pressures and temperatures encountered in the superficial parts of the earth could have such an effect. It has been suggested by Prof. Joly that the absolute age of a gram of uranium may affect its rate of disintegration. All possibilities should be considered, but this suggestion derives no support from the behaviour of the shorter-lived radio-active substances the behaviour of which we can watch.

Upon the whole, therefore, it would seem that in the disintegration of a gram of uranium we have a process the rate of which can be relied upon to have been the same in the past as we now observe it to be.

The application is either to individual uranium minerals or to the earth's crust as a whole. Taking first the minerals containing uranium, these are found in all cases to contain helium and lead. The helium in them, which appears to be retained mechanically, may safely be treated as wholly a radio-active product. The lead in some cases conforms closely to the expected atomic weight of 206, about one unit lower than common lead, and in such cases we may safely regard the whole of it as a product of uranium disintegration.

[2] Ordinary lead may partly consist of it, but this is not yet certain, and not very important for the immediate purpose.

Thus take the broggerite found in the pre-Cambrian rocks at Moss, Norway. The lead in this mineral has an atomic weight of 206·06 as determined by Hönigschmied and Fräulein St. Horovitz. The ratio of lead to uranium is 1 : 3. Taking the lead as all produced by uranium at the rate above given, we get an age of 925 million years. Some minerals from other archæan rocks in Norway give a rather longer age.

In other cases there is some complication, owing to the fact that thorium is associated with uranium in the mineral and that it, too, produces helium and an isotope of lead of atomic weight probably 208 exactly, about one unit higher than common lead.

In a third class of cases the uranium mineral, pitchblende, occurs in a metalliferous vein, and the lead isotope produced in the mineral is diluted with common lead which entered into its original composition.

These various complications introduce a certain amount of difficulty and even ambiguity into the interpretation. A full discussion cannot be given on an occasion like the present, but the complications cannot, I think, be considered to modify the broad result.

A determination of the amount of helium in minerals gives an alternative method of estimating geological age; but helium, unlike lead, is liable to leak away, hence the estimate gives a minimum only. I have found in this way ages which, speaking generally, are about one-third of the values which estimations of lead have given, and are, therefore, generally confirmatory, having regard to leakage of helium.

The helium method is applicable in some cases to materials found in the younger formations, and proves that the ages even of these are to be reckoned in millions of years. Thus the helium in an Eocene iron ore indicated thirty million years at least.

Returning now to the estimation of lead, H. N. Russell has recently applied this line of reasoning to the earth's crust as a whole. He takes the uranium in the earth as 7×10^{-6} of the whole, and the lead as 22×10^{-6} of the whole. It is necessary to remark that we do not know very definitely whether the lead distributed in the rocks in small proportion and very difficult of extraction is the same mixture of isotope as the lead of mineral veins. We call the latter "common lead," but nearly all the lead in the earth's crust is of the former kind.

Even if we did know that "rock lead" were the same as "vein lead," we should still not be in a position to say what fraction of it was uranium-lead, as we do not know whether an isotope having an atomic weight 207 exists. If it does, obviously the problem how much uranium-lead (atomic weight 206) and how much thorium-lead (atomic weight 208) exists in common lead (atomic weight 207) becomes indeterminate in the absence of further data. An analysis of lead by positive rays will probably soon become feasible, and with a determination of the atomic weight of "rock lead" will do much to clear up the matter.

If all the lead were uranium-lead, and had been generated since formation of the earth's crust, the time required would be 11×10^9 years. This is certainly too great. Allowing for the production of some of the lead from thorium, Russell finds a period of 8×10^9 years as the upper limit. This is about six times the age indicated by the oldest individual radio-active minerals that have been examined.

I have now traversed that part of our subject of which I feel competent to speak. The upshot is that radio-active methods of research indicate a moderate multiple of 1000 million years as the duration of the earth's crust as suitable for the habitation of living beings, and that no other considerations from the side of pure physics or astronomy afford any definite presumption against this estimate.

The arguments from geology and biology I must leave to our colleagues from other sections. May I venture to say that I for one consider the topics with which they will deal as not less interesting and important than those which it has been my privilege to try to lay before you.

By PROF. W. J. SOLLAS, F.R.S.

HUXLEY once sagely remarked that the zoologist must take his time from the geological clock. The geologist is thus charged with a great responsibility which he would willingly share with the physicist and astronomer. One of the earliest attempts to determine the age of the earth by purely geological means was made by the late Dr. Samuel Haughton, who based his calculations on the rate of deposition of sediment supposed to be evenly distributed over the whole floor of the ocean. This led to the conclusion that the time which must have elapsed since the first appearance of the dry land is of the same order of magnitude as that now presented for our consideration by Lord Rayleigh.

Soon, however, it was discovered, as a result of exploration by the *Challenger*, that deposition is limited to a comparatively narrow belt bordering the continents—a limitation due to several causes, chief among them the fact that sediment sinks much more rapidly in salt water than fresh. On taking account of this factor Haughton's period was reduced to about 100 million years. At the same time a new method was devised by Prof. Joly which depends on the rate at which sodium is supplied to the sea, and this led to a similar result.

Antecedent to these attempts, another method, based on the rate at which the earth is losing heat, had been employed by Lord Kelvin, and this gave at first an estimate concordant with the preceding—*i.e.* 100 million years. Later, how-

ever, this allowance was reduced to forty, or preferably to twenty, millions, and by the uncompromising Prof. Tait to ten millions.

These estimates proved very embarrassing to the geologist, who found it impossible to compress the events of the earth's history into so restricted an interval without unduly "hurrying up the phenomena." Lord Kelvin, however, was inflexible, and impressively asserted that he could conceive of no escape from his conclusions.

With the discovery of radioactive elements the inconceivable happened, and Lord Rayleigh was amongst the first to perceive that the rate of disintegration of uranium might be used to provide the geologist with a trustworthy timekeeper. By his experiments and reasoning he not only enlarged our views on the duration of geological time, but also opened the way to other methods of investigation which in the hands of Prof. Joly and Dr. Holmes have yielded concordant results.

The age of the earth was thus increased from a mere score of millions to a thousand millions and more, and the geologist who had before been bankrupt in time now found himself suddenly transformed into a capitalist with more millions in the bank than he knew how to dispose of.

The consequences have been far-reaching; already some geologists, thus newly enriched, chief among them the brilliant Barrell, whose loss we still deplore, have begun to rebuild their science on a new and magnificent scale, while more cautious people, like myself, too cautious, perhaps, are anxious first of all to make sure that the new clock is not as much too fast as Lord Kelvin's was too slow. Lord Rayleigh does not regard this as inconceivable, but as unlikely. Prof. Joly, on the other hand, can not only conceive a source of error, but has obtained evidence which seems to show where it lies. This is furnished by a study of the well-known pleochroic haloes which surround minute uranium- or thorium-bearing crystals included in the black mica of granite. By a very elegant method of investigation he shows that these furnish estimates of geological time of the same order as those established by Lord Rayleigh and Dr. Holmes; but he does not stop there; he goes further. The haloes consist of a number (seven) of concentric rings due to the bombardment of the mica by the α-rays which are emitted by the uranium or the thorium, as the case may be, and their products of disintegration. The outermost of these rings is due to radium C, the innermost to uranium or thorium. From data provided by experiment it is possible to calculate the dimensions of the rings, and in the haloes due to thorium the length of the radii obtained by direct measurement agrees very precisely with that obtained by calculation, and this agreement holds, not for some of the rings only, but for all. A similar agreement is found for the rings of the uranium haloes with the remarkable exception of the innermost two, due to uranium and its immediate product, ionium. These are larger than they should be; in fact, the length of the radius of the uranium ring as actually observed is one-sixth longer than that predicted by calculation. This shows that when the haloes began to be formed—*i.e.* in Caledonian times—the range of the α-rays emitted by the uranium-bearing crystal was greater than it is now, and hence probably that a metope of uranium then existed with possibly very different properties from the uranium now known to us.

If Prof. Joly's conclusions are sound, it is clear that the uranium clock has not been keeping uniform time, and the change of rate in the disintegration of uranium is as much in question as the age of the earth. The problem is a physical one, and geologists must leave it in the hands of the physicists while anxiously awaiting its solution.

It would not be fair to end here without admitting, what Prof. J. W. Gregory's remarks will sufficiently reveal, that geologists are not an undivided family. There are some who welcome the expansive vistas now opened to their view, and Barrell has already attempted to readjust the geological perspective. He pointed out how the calculations of the earth's age, based on the thickness of deposits and the existing rate of deposition, as well as those based on the amount of sodium in the ocean, may be vitiated by a too servile interpretation of the doctrine of uniformity. The rate of disintegration of uranium may have changed, but so may the rate of denudation and deposition; so far from being constant, it may have increased with the progress of time, so that a foot of sediment which in the Pleistocene epoch accumulated, according to Barrell, in the course of 375 years would have required no less than 3700 years for its formation in the early days of the Palæozoic era. Thus at a period when the earth was more highly charged with energy its activities were diminished. We must no longer picture a time when the earth was "young and wantoned in her prime," but must suppose that she has exchanged the passive indolence of youth for the fiery activity of old age.

In support of his views Barrell pointed out that the continents of the present day are more elevated as a whole than they were during a great part of geological time, and that their interior is not flooded to so great an extent by continental seas. It is doubtful, however, whether this would greatly affect those estimates which have been based on the maximum thickness of sedimentary deposits, for this is only to be found in the foredeeps which lay in front of mountainous lands and lands now vanished from our sight.

Barrell also laid great stress on the occurrence of gaps in the stratified series, unconformities, disconformities, and still smaller lacunæ which he termed diastemata. Of the important bearing which unconformities must have upon this discussion there can be no doubt. They were not overlooked in arriving at an estimate of 100 million years. The disconformities are only now beginning to receive the attention to which their

importance entitles them. In our own country we are familiar with them in the Jurassic system, but with us this system is far from attaining its maximum thickness—it does not exceed 8000 ft.—while elsewhere it is represented by deposits of 20,000 ft. or more. The presence of numerous and well-marked disconformities in the British Jurassic rocks is, therefore, not surprising; whether they have the same importance in areas of maximum deposition has yet to be shown.

The estimates based on the rate at which sodium is supplied by rivers to the sea are in remarkable agreement with those derived from a study of stratified deposits. The objection that most of the sodium in river water has been directly derived from the sea was raised long ago by Mr. Ackroyd, of Halifax, but was shown on investigation to be invalid.

No importance can be attached to the salinity of the sea in the early part of the Cambrian epoch, for as much time or more had elapsed before that period as followed after it. The first era of geological time, which has been called the Protæon, and the second, or Deuteræon, are of approximately equal length. From what we know of the behaviour of existing marine forms when exposed to brackish water conditions we have no reason to suppose that the Cambrian faunas could not have flourished in a sea only half as salt as the existing ocean.

Juvenile waters, often rich in sodium and chlorine, no doubt contribute to the contents of existing rivers, but if, as seems likely, they furnished a larger contribution in past times, the effect would be to shorten instead of lengthening Prof. Joly's estimate.

Finally, it may be pointed out that in the only instance where estimates based on the thickness of deposits can be brought into comparison with a stricter determination of time the former have been found in excess. This stricter determination is due to Baron de Geer, who, by counting the number of annual layers of sediment left behind by the great ice-sheet in its retreat, found for the duration of post-glacial time a period of 12,000 years, and thus shorter by several thousand years than those arrived at from a study of the post-glacial deltas in the Swiss lakes.

Geologists are not greatly concerned over the period which physicists may concede to them; they do not much care whether it is long or—in moderation—short, but they do desire to make reasonably certain that it is one which they can safely trust before committing themselves to the reconstruction of their science, should that prove to be necessary.

By PROF. J. W. GREGORY, F.R.S.

THE claim that geological time must be restricted within a score, or a few score, million years was regarded by most geologists with incredulity, since a score million years was of little more use to geology than the seven days of the Pentateuch. Now that physical evidence allows the age of the earth to be counted by the thousand million years the problem is of less concern to the geologist, except from the hope that the uranium-lead ratio may fix geological dates in years, and from the interest of reconciling the conflicting results of the different methods.

The geological estimates to which most weight has been attached are based on the saltness of the sea. The salinity argument has been widely accepted as sound in principle; the estimates varied from 70 to 150 million years, and some intermediate length was regarded as inevitable. Allowances were made for various factors; but they added only a few per cent. to the total, and did not multiply it by ten or more.

The validity of the salinity argument may be tested by two checks—the supply of chlorine, and the denudation required to account for the amount of sodium; and as shown by Dr. A. Holmes, each of these indicates a much longer period than the sodium.

The supply of chlorine in igneous rocks is quite inadequate to convert their sodium into chloride. Most of the sodium chloride in river water is probably marine in origin, and only the sodium in the bicarbonate and sulphate is a fresh addition to the sea. On this ground the salinity estimate should be approximately doubled. Again, to obtain all the sodium in the sea from igneous rocks would involve the denudation of improbable volumes of them, and, at the rate usually accepted, the age of the earth should be multiplied three- or four-fold.

The fundamental objections to the salinity argument are against (1) its assumption that the sea was originally fresh, which palæontological evidence renders improbable: the oldest fauna, the Cambrian, has the characteristics of a marine fauna, and the contrast between the freshwater and marine faunas was as sharp in Palæozoic times as it is to-day; (2) its omission to allow for the large supplies of sodium chloride raised from beneath the earth's surface by magmatic waters; (3) its assumption of uniform denudation. The earth has probably undergone deformations that led to alternate periods of quick and slow crustal movement; during the times of repose the surface would have been planed down and rivers would have become sluggish and denudation slow. As the earth is now under the influence of a time of quick movement, denudation is faster than the average. A multiplication of the earth's age five-fold for this difference would not be excessive.

During quick crustal movement volcanic action would be more powerful, the discharge of hydrochloric acid and sodium in hot springs would be increased; and as denudation is now acting on land in which sodium chloride has been produced in unusual quantities by volcanic action the esti-

mated age of the earth must be again extended. The rhythmic acceleration of geological processes lengthens the estimates based on sedimentation, but would affect the biological argument inversely, since at periods of rapid physical change biological change would have been quickened, and thus the occasional abrupt introduction of a new fauna does not necessitate so long an interval as has been thought.

The best-known geological estimates of the age of the earth require to be multiplied ten- or twenty-fold in order to agree with the physical estimates, but this increase is consistent with the geological evidence.

By Dr. Harold Jeffreys.

THE rate of denudation must have varied very considerably during the earth's history, for it depends on both the height of the land and on the meteorological conditions, both of which have certainly changed very much from time to time. The consistency of the various geological methods among themselves does not prove that there has been no change in the rate of denudation, for such a change would affect them all in the same ratio.

Prof. Eddington's argument shows that there must be an unknown source of energy in the Cepheid variables. It is possible, however, to infer from the condition of the earth that its own age must be much greater than the Kelvin theory allows, and therefore the sun itself must have such a source of energy. The rate of increase of temperature downwards in the earth's crust is the sum of three parts, one depending on the original temperature at the surface, one on the original increase of temperature downwards, and one on the radio-active emission of heat. With the best data available, supposing the time elapsed since solidification to be $1{\cdot}6\times10^9$ years, all the known facts regarding the earth's thermal condition can be co-ordinated. If the age is supposed to be $1{\cdot}6\times10^7$ years, however, the data cannot be reconciled: the part of the increase of temperature downwards depending on the initial temperature at the surface is by itself greater than the present rate.

If we force an approximate agreement by supposing that the original temperature was uniform and that radio-activity does not exist at depths greater than a kilometre, we can calculate the amount of surface compression available for mountain building, the thickness of the layer of the crust which has cooled considerably and therefore become geologically strong, and the depth to which compressive movements in the crust extend. In each case the results are inconsistent with the geological and geodetic evidence, while the greater estimate of the age of the earth agrees well. We have, in fact, the following comparison:—

	Calculated.		Actual.
	Assumed age of earth		
	$1{\cdot}6\times10^9$ years.	$1{\cdot}6\times10^7$ years.	
Area compressed (km.^{2}) ...	49×10^5	5×10^5	$>19\times10^5$
Greatest depth of considerable cooling (km.) ...	300	30	100–400
Depth of compressive movements (km.)	70	1	>10

I do not agree with Lord Rayleigh's suggestion that the earth must be becoming hotter. That hypothesis is not acceptable on cosmogonical grounds, and Dr. Holmes has shown that it is impossible to reconcile it with the existence of volcanic temperatures, and that there must be a concentration of radio-active matter in the upper layers of the crust. Dr. Holmes has told me privately that there is reason to believe that in a fluid magma the radio-active materials will be concentrated in the upper layers on account of the volatility of their compounds, but I do not know whether this argument has been published. The numerical estimates here given rest on the supposition of such a concentration.

An alternative estimate of the age may be made from the tidal theory of the origin of the solar system, the only theory which is not unsatisfactory on dynamical grounds. The planets must, on this theory, have moved originally in highly eccentric orbits, and have had their eccentricities gradually reduced by the action of a gaseous resisting medium. If the density of the medium near Mercury was ρ, the time needed to reduce the eccentricity to its present value would be of the order of $4000/\rho$, C.G.S. units being used. On the other hand, the time it would take the medium to be dispersed by viscosity and diffusion would be of the order of $16\times10^{29}\rho$. These must be equal; for if the former was the greater the medium would have dispersed before doing the work, and if the latter was the greater the medium would still be a conspicuous object. This shows that the time needed was of the order of 8×10^{16}sec. or $2{\cdot}5\times10^9$ years, agreeing with the estimate given by the uranium-lead ratios.

Obituary.

Dr. A. S. F. Leyton.

BY the death of Dr. Albert Sidney Frankau Leyton on September 21, at fifty-two years of age, we lose a worker who, through his researches in pathology, contributed much to medicine. The value of these researches, though appreciated by those who follow closely the advance in scientific medicine, will come to be fully recognised only when the history of the development of that science during the last four decades is written. Dr. Leyton, the son of Joseph Grünbaum, who early in life settled in this country, had a brilliant scholastic career, first in the City of London School and then at Cambridge, where he was elected a scholar of Gonville and Caius College, and proceeding to his

degree, gained honours in the natural sciences tripos. He completed his clinical studies at St. Thomas's Hospital, and graduated M.D. in 1897 and D.Sc. in 1913.

Those who knew Dr. Leyton best maintain that some of his most valuable work was that carried out in Vienna in the winter of 1896, when, working in the Public Health Laboratory, he turned to practical account the work of Gruber and H. E. Durham by applying it to the diagnosis of typhoid fever. Unfortunately, his results were not published until July of the same year, and Widal, of Paris, publishing in June, anticipated by one month his claim to priority in the agglutination test for typhoid fever. Many workers now maintain that this test should be known as the Durham-Grünbaum test. As the facts are now known, the nomenclature becomes a matter of comparatively slight importance.

On his return from the Continent Dr. Leyton acted as demonstrator for Prof. C. S. Sherrington in the physiological department of the University of Liverpool, and collaborated with him on a series of researches on the brain of the gorilla and the chimpanzee, the outcome of which were papers on the anthropoid motor cortex published in the Proceedings of the Royal Society in 1901 and 1903. This work, continued, forms part of the foundation on which Prof. Sherrington built up his magnificent contribution to our knowledge of the development and functions of the central and peripheral nervous system. For a time he also held the post of assistant physician in the Hospital for Consumption, thus broadening the basis of his professional knowledge.

Investigating the cause of scarlet fever, Dr. Leyton was able to show that the disease can be transmitted to the anthropoid apes, and in 1904, whilst lecturer in experimental medicine in the University of Liverpool, he published, in the *British Medical Journal*, an account of his experiments under the title of "Enterica, Scarlet Fever, and Measles in Anthropoids."

Dr. Leyton was then appointed director of the Liverpool Cancer Research Institution. Here he commenced the publication of a series of papers, of which those on the etiology of sarcoma, the "treatment of sarcoma," and "streptothrixes from tumours" are perhaps the most important. Elected to the fellowship of the College of Physicians in 1902, he was selected to deliver the Goulstonian lectures, and took as his thesis "Theories of Immunity and their Clinical Application." On his appointment to the chair of pathology in the University of Leeds he continued and extended his studies on hæmolysis, agglutinative action, etc., for the diagnosis of enteric fever and anaphylaxis. He also undertook the direction of the Clinical Pathological and Bacteriological Laboratory of the Corporation, and organised a thoroughly sound and helpful diagnostic service. Entering fully into the work of the university, he soon proved his business capacity, and was made dean of the medical faculty, an office in which he rendered valuable service to medical education and to his university. During this period he published a "practical" manual on the essentials of histology, a work still popular amongst students of morbid histology.

On the outbreak of war Dr. Leyton was appointed bacteriological consultant to the Northern Command, and undertook a series of investigations on trench fever. Unfortunately, contracting kidney disease, he had a cerebral hæmorrhage before the end of the war, and was compelled to retire both from the service and from his professorship. Taking up residence in Oxford, he so far recovered that he was able to engage on some historical research, and later, on the death of Dr. Malden, the director of the Clinical Laboratory at Addenbrooke's Hospital, Cambridge, in 1919, he was appointed his successor, and for some time rendered valuable assistance to the hospital staff. Some months ago, however, he had further attacks of cerebral hæmorrhage, and although his wife was able to relieve him by undertaking much of his work, he had for some time before his death been unable to work in the department.

Dr. Leyton—a name adopted by deed poll early in the war—is survived by Dr. Helen Gertrude, widow of Dr. Robert S. Stewart—whom he married in 1909—and two sons. He was always recognised by his fellows as being a man of marked ability and great industry and perseverance. He possessed powers of lucid and concise exposition, a well-ordered, logical mind, and was capable of doing good work in connection with anything he undertook. He was direct in his approach to, and incisive in his methods of dealing with, scientific and practical problems of all kinds, but he was of a shy, nervous, and even retiring disposition, and, like so many men of his type, he often sought shelter beneath a carapace of brusqueness and cynicism little characteristic of the real man. Those who gained his friendship were continually afforded glimpses of the real kindness and sympathy that he had for friends and for those less well situated than himself.

Dr. Leyton was a trained physiologist, a skilled experimentalist, and an excellent morbid anatomist and bacteriologist, and much of his work will stand. To his old school and to others with which he later became associated he was ever loyal. Had he been spared to publish the results of his work and wide experience his contributions to the science of medicine would undoubtedly have been still more numerous, and medical literature would have been greatly enriched. Many will feel that they have lost a real friend and a clear and capable teacher. G. S. W.

SIR WILLIAM GARFORTH.

By the death of Sir William Garforth, in his seventy-sixth year, at Snydale Hall, Pontefract, the country has lost a leader of industry, a mining

engineer and inventor of more than ordinary ability, and a man who has left his mark on the mining industry with which he had been connected from boyhood. His work in connection with coal washing, coal cutting, prevention of accidents in mines by the adoption of systematic and orderly methods of mining, mine rescue appliances, safety lamps, and stone dust as a remedy for colliery explosions, has had a far-reaching influence in the development of mining in this country.

Sir William Garforth invented "stone-dusting" from having observed that in an explosion in his colliery the explosion stopped whenever it met a road in which there was loose shale dust. He had maps drawn to illustrate this, and in lectures and speeches constantly advocated the use of stone dust to prevent colliery explosions. Finally, at his colliery he erected a model mine composed of old cylindrical boilers bolted end to end. Coal-dust explosions were promoted in this gallery, with and without the presence of stone dust. These experiments were strikingly successful. He paid part of the expenses himself; part was very generously subscribed by other coal owners. Eventually the matter was taken up by the Home Office and referred to a Royal Commission which was provided with a certain sum of money to carry out experiments. This sum was supplemented by grants from the Coal Owners Association and by the loan of the tube and all the instruments which Sir William Garforth had used.

Sir William's experiments were repeated at Eskmeals and his contentions were confirmed. The remedy so amply demonstrated was discounted by the suggestion that the application of inert dust of this nature would produce consumption amongst the mine workers. It therefore became desirable to test this point. The work had been taken in hand by the Home Office, and as there were no funds available, Sir William provided the Chairman of the Royal Commission with money, only stipulating that his name should not be mentioned. Stone-dusting in mines has become a regular practice, and when it becomes universally adopted there is no doubt coal-dust explosions will be entirely eliminated from our mines. Sir William's work on mine rescue apparatus also had a great influence in the industry. He was rewarded by seeing a medal conferred upon one of his own miners who used his apparatus in the rescue of some imprisoned men.

To those who knew Sir William Garforth he was a warm friend. He was a man of singular breadth of view; with a great deal of Yorkshire doggedness he combined a very open mind, being always ready to sacrifice his views if they were shown to be wrong. The recent strike went very much to his heart. He had always taken a pride in demonstrating to his friends the good terms he maintained with his miners, and even in a district in which the Featherstone riots had occurred he was always greeted with a smile whenever he went to the mine. But during the last strike the temper had changed, and in the opinion of one of his friends who saw him this summer it contributed to a depression which ended in heart failure. He was a typical coal owner, a typical Yorkshireman, and a typical Englishman, and it will be a bad day for the country if such men are to disappear.

THE death is announced of M. ALFRED GRANDIDIER, the eminent French geographer and explorer, on September 12, at the age of eighty-four years. M. Grandidier began his travels at an early age when, accompanied by his brother, M. E. Grandidier, he made a tour of the world, devoting much time to journeys in the little-known plateau of Bolivia and the cordilleras of southern South America. In 1863 he set out for India with the intention of trying to penetrate into Tibet. To equip himself for that difficult journey he proposed to spend some time studying Buddhism in Ceylon. Illness, however, caused him to change his plans and took him to Zanzibar, and later to Madagascar, where he landed for the first time in 1865. During the next five years M. Grandidier spent most of his time in that island exploring its almost unknown interior and crossing it in several directions, besides carrying out important anthropological and linguistic work. On his explorations are based the first accurate knowledge and the first general map of Madagascar, and the *Revue Scientifique*, in a notice of his work, points out that M. Grandidier was largely instrumental in establishing French rule and order in Madagascar. His great work, "L'Histoire politique, physique et naturelle de Madagascar," on which he had been engaged for the last half century, is still incomplete, although some ten volumes have already been published. Its completion is now to be undertaken by his son. M. Grandidier received the Gold Medal of the Paris Geographical Society in 1872, and was President of the Society from 1901 to 1905; he was also a member of the Institute of France, and last July was made a commander of the Legion of Honour.

THE death is announced, in his fifty-eighth year, of DR. JOSEPH W. RICHARDS, professor of metallurgy since 1903 at Lehigh University, where he had served for several years previously as instructor and assistant professor. In 1902 he was elected the first president of the American Electro-Chemical Society, and he was also a member of the Faraday Society and the Iron and Steel Institute. He had been a member of many technical boards and juries at expositions, as well as of the U.S. Navy Consulting Board. His contributions to scientific literature were concerned mainly with blast-furnace operations and the electro-metallurgy of iron and steel.

WE are informed that MR. BENJAMIN HARRISON died on September 30, and not on October 1, as stated in last week's issue of NATURE, p. 251.

Notes.

THE president and council of the Royal Society announce that, in view of the economic condition of the country, the anniversary dinner of the society will not be held this year.

THE discovery of a fossil forest is reported at Anglon, Sardinia. Petrified palms, with well-preserved structure, are already known from a Miocene formation in the island, and details of the new find will be awaited with interest.

THE *Daily Mail* Imperial Fruit Show will be opened by the Right Hon. Sir Arthur Griffith-Boscawen, Minister of Agriculture and Fisheries, at the Crystal Palace on Friday, October 28, at 3 p.m.

A NEW series of geophysical discussions, to be held in the rooms of the Royal Astronomical Society, will be opened on Friday, November 4, at 5 p.m., with a discussion on "The Eötvös Gravity Balance." The chair will be taken by Col. Sir C. F. Close. Col. H. G. Lyons will open the discussion, which will be continued by Prof. C. V. Boys, Col. E. H. Grove-Hills, and Col. Sir G. P. Lenox-Conyngham.

THE 168th session of the Royal Society of Arts will be opened on Wednesday, November 2, at 8 p.m., when Mr. Alan A. Campbell Swinton, chairman of the council, will deliver an experimental address on "Wireless Telegraphy." Among the papers fixed for the meetings up to Christmas are the following: The Work of the Industrial Fatigue Research Board, by D. R. Wilson; Modern Buildings in Cambridge and their Architecture, by T. H. Lyon; The Coming of Age of Long-Distance Wireless Telegraphy and some of its Scientific Problems (Sir Henry Trueman Wood Lecture), by Prof. J. A. Fleming; and The Preservation of Stone, by Noel Heaton.

AT the Royal Horticultural Society on Tuesday and Wednesday of next week Lord Ventry will show New Zealand flax-plants (*Phormium tenax*) grown at Dingle, Co. Kerry, and twine, etc., prepared from the plants grown in Ireland. The exhibit will be an interesting one as the flax is growing thoroughly well in south-west Ireland. The leaves are 10 ft. 6 in. long, and Lord Ventry has proved that the Dingle peninsula can produce binder-twine for the whole of the United Kingdom (estimated at 20,000 tons). He has been working hard with the flax, and his efforts are very interesting and worthy of careful attention. An account of his experiments was given in the *Kew Bulletin*, 1919, p. 146, with plates, and the first report on the Flax Production Branch of the Ministry of Agriculture appeared a couple of years ago (see NATURE, October 2, 1919, vol. 104, p. 98).

AT the annual statutory meeting of the Royal Society of Edinburgh, held on October 24, the following office-bearers and council were elected: *President:* Prof. F. O. Bower. *Vice-Presidents:* Sir G. A. Berry, Prof. W. Peddie, Sir J. A. Ewing, Prof. J. W. Gregory, Major-General W. B. Bannerman, Dr. W. A. Tait. *General Secretary:* Dr. C. G. Knott. *Secretaries to Ordinary Meetings:* Prof. E. T. Whittaker, Prof. J. H. Ashworth. *Treasurer:* Dr. J. Currie. *Curator of Library and Museum:* Dr. A. Crichton Mitchell. *Councillors:* Mr. H. M. Cadell, Prof. A. R. Cushny, Prof. F. G. Baily, Mr. G. J. Lidstone, Dr. R. Campbell, Principal J. C. Irvine, the Hon. Lord Salvesen, Prof. J. Arthur Thomson, Dr. H. S. Allen, Sir R. B. Greig, Dr. J. Ritchie, and Dr. E. M. Wedderburn.

THE new board of the Institute of Physics is constituted as follows:—*President:* Sir J. J. Thomson. *Past-President:* Sir Richard Glazebrook. *Vice-Presidents:* Prof. W. H. Eccles, Major E. O. Henrici, Prof. C. H. Lees, and Mr. C. C. Paterson. *Treasurer:* Sir Robert Hadfield, Bart. *Hon. Secretary:* Prof. A. W. Porter. *Members:* Inst. Comdr. T. Y. Baker, Mr. J. E. Barnard, Dr. R. S. Clay, Mr. W. R. Cooper, Prof. C. L. Fortescue, Prof. Andrew Gray, Dr. G. W. C. Kaye, Sir Charles Parsons, Mr. C. E. S. Phillips, Dr. E. H. Rayner, Prof. S. Russ, Mr. F. E. Smith, Sir Napier Shaw, and Mr. R. S. Whipple. Particulars relating to the institute can be obtained from the secretary, Mr. F. S. Spiers, O.B.E., 10 Essex Street, London, W.C.2.

THE establishment of a diploma in medical radiology and electrology by the University of Cambridge was made at the instigation of the British Association for the Advancement of Radiology and Physiotherapy (B.A.R.P.). This association has also been instrumental in forming a Society of Radiographers, having as its object the consolidation of the position and improvement of the status of the lay assistant who carries out the routine work at hospitals under the direction of the medical head of the department. The council of the Society of Radiographers has arranged for an examination to be held yearly, and instruction for this examination is being greatly facilitated by the co-operation of the Institution of Electrical Engineers. Successful candidates will be entitled to use the letters M.S.R. These dual activities of the B.A.R.P. are a good augury of the desire among radiologists to improve the status of medical work involving the use of the various forms of electricity and radiation.

THE Government of Czecho-Slovakia has recently concluded an agreement with the Imperial and Foreign Corporation which, it is expected, will have important consequences for this country in securing a supply of radium for medical uses. Under the agreement the output of radium from the celebrated State mine at St. Joachimsthal (now Jachymov) for the next fifteen years will be loaned to a new company that has been formed, known as the Radium Corporation of Czecho-Slovakia. The latter will start a laboratory and offices in this country for the sale and hire of radio-active preparations, in the first place to the medical profession. A quantity of two grams of radium element, as the first instalment under this agreement, was recently brought from Prague by

Prof. Soddy, and a similar amount is expected annually. The Czecho-Slovakian Government retains its proprietary rights in the radium, which is to be returned at the termination of the agreement. By this enterprise a close connection between this country and the chief European source of radium has been established which, it is to be anticipated, will prove ultimately of advantage to workers in this subject.

THE first annual report of the Electricity Commissioners (H.M. Stationery Office, price 3s. net) is of interest. It shows clearly that although improvements in the existing conditions of electric power supply cannot be realised as rapidly as was anticipated when the Act of 1919 was passed, yet substantial progress has been made in securing the co-operation and agreement of the authorities in particular districts. It is not a problem of starting *ab initio* to develop a comprehensive and standardised system of distribution in the light of our present-day knowledge and technical practice. There exist many heterogeneous systems of supply which have to be adapted, modified, and expanded to meet the growing needs of the community. The present financial stress has also proved a barrier to rapid developments. The standardisation of 50 as the frequency of supply proved impracticable, and so the subsidiary frequencies of 40 and 25 had to be permitted. It is satisfactory to note that the Commissioners have approved in several cases of very high voltages for the transmission of power. In Northumberland and Durham, for instance, the electric energy will be distributed from the main generating stations to the sub-stations at a pressure of 66,000 volts. From Woolwich to Erith the pressure of transmission will be 33,000 volts. With these high voltages appreciable economies can be effected. The Commissioners have now come to a stage in their proceedings where their decisions will affect adversely many interests, but luckily they have secured the universal esteem of the profession

THE Geographical Society of Paris celebrated its centenary in July last. Having been founded in 1821, it is the oldest geographical society in the world, and nine years senior to the Royal Geographical Society. In commemoration of the event the society has devoted an enlarged number of *La Géographie* (July–August) to a history of the society and a record of the centenary celebrations. From the year of its foundation, under the presidency of the Marquis de Laplace, the society has grown in usefulness and influence. An outgrowth of the society in 1870 was the foundation of the numerous French provincial geographical societies, which now number more than twenty, while the growing overseas interests of France led in 1876 to one branch of the society becoming the Société de Géographie commerciale with an independent organisation. The International Geographical Congresses which met from time to time before the recent war were inaugurated by the society at Paris in 1871, and Paris was again the meeting-place in 1875 and 1889. From 1822 the society has published its Bulletin, now known as *La Géographie*, which has always been particularly rich in African travel. In addition, it has from time to time published a large number of separate geographical works. The centenary celebrations included a reception by the president of the society, Prince Roland Bonaparte; a meeting presided over by President Millerand, at which addresses were presented by various geographical societies, including the Royal Geographical Society, represented by Sir F. Younghusband; visits to the Bibliothèque nationale and the Service hydrographique de la Marine; an afternoon municipal reception at the Hôtel de Ville: and the concluding banquet.

THE annual general meeting of the Chaldæan Society was held at the Great Northern Hotel, King's Cross, on Saturday, October 15. The president, Mr. J. Hargreaves, in reviewing the work of the year and the progress of the society, stated that there were now seven local sections, as against two last year. The first of these sections to be formed, at Luton, had had a very busy season, while those at Letchworth and Ipswich were now well established. The two London sections, north and south, in spite of the large population, or rather because of it, still found it difficult to carry out satisfactory astronomical work. In this sense their record was comparatively disappointing. The Rev. D. R. Fotheringham, editor of *The Chaldaean*, advised the society to pay special attention to naked-eye work. He suggested that members should watch for and record specially:—(1) The first appearance of planets after conjunction with the sun; (2) every appearance of Mercury; (3) any appearance of Vesta, other minor planets, naked-eye comets, or Uranus; (4) observations of naked-eye variable stars like Mira Ceti or Algol; (5) haloes; and (6), for those with keen sight, the careful mapping of the Milky Way. The 1921 eclipse report was formally presented to the meeting. Detailed accounts were submitted from Lochmaddy and Thurso, whence the eclipse had been seen in its annular form, and tabulated reports were presented from fifty-six other stations, embodying temperature records, appearance of stars, effect on animals, etc. A discussion followed on the relationship of local sections and the central body of the society. The following were elected officers for the year:—*President:* Mr. J. Hargreaves. *Secretary:* Mr. E. W. Foster. *Treasurer:* Dr. J. K. Fotheringham. *Librarian:* Mr. G. S. Clark Maxwell.

PARAGRAPHS have lately appeared in the daily Press reporting the occurrence of oil in a water well at Bosham, near Chichester, Sussex, and in particular the *West Sussex Gazette* of October 13 gave an account of the visit of an inspector from the Petroleum Department to this well. The facts briefly are as follows:—The well is situated in the garden of Mr. H. Richardson, of Bosham. Recently a clear oil was noticed on the surface of the water, and it is reported that no less than 100 gallons of "almost pure paraffin" were later obtained. The inspector apparently did not commit himself as to whether the oil was a natural or fortuitous occurrence, but the idea that this is indeed a natural oil has gained

currency, notwithstanding the obvious technical objections to such a view. Similar oil finds have been reported before in this country. In that near Peterborough a few years ago, leakage from surface stores was ultimately held to account for the "discovery." At Bosham, on the other hand, we are informed that there are no likely stores near at hand from which the oil could have been derived by leakage, and this has done much to inspire the prevailing optimism with regard to the occurrence. Our only comments at this stage are: first, the possibility of floating oil on the water of Bosham Creek (a tributary of Chichester Harbour) in these days of oil-fired ships is not to be passed over, and the well may quite conceivably have suffered contamination from this source; secondly, Bosham itself is situated on the chalk, here brought to the surface by the Portsdown anticline; one does not usually associate oil and chalk, in fact the only possible oil-bearing horizon here (and that an extremely unlikely one) is the Kimmeridge Clay, which lies at far too great a depth to be taken into serious consideration. The anticline, while structurally favourable from the point of view of oil accumulation, is scarcely likely to lead anyone but the "get-oil-anywhere" fraternity astray. Its occurrence at the same point as this supposed oil find is merely one of those strange coincidences which are absolutely devoid of significance.

In a Chadwick public lecture delivered on October 20 on the subject of "Plant Diseases and their Relation to Diseases in Man," Prof. V. H. Blackman said that the plant pathologist is faced by the very wide range in the degree of association of the host and the parasitic organism. At one extreme there is the condition where the fungus is almost purely superficial and the injurious effect is mainly indirect; at the other extreme there are associations of host and fungus, known as symbiosis, in which association benefits both the organisms. Between these two extremes there are all degrees of association of the two organisms. Plant-cells, when once penetrated, are almost always killed, and plants generally depend for immunity from disease on their capacity to keep the parasite out or to render it harmless by enclosing it within layers of cork. The immunity of certain wheats from rust disease has, however, been shown to be due to the "hypersensitiveness" of the tissues, which succumb so rapidly to the attack of the fungus that the parasite is starved. It is only in cases of symbiotic association that there has been observed any digestion of the invading organism comparable with phagocytosis in animals; in the orchids also there is evidence that plants once infected are immune from further attack. No production by the attacked plant of lethal substances comparable with antitoxins, bacteriolysins, etc., have been observed, so the possibility of artificial immunisation of plants by the use of vaccines or sera would seem to be very unlikely. Apart from the difficulty of distributing such vaccines to the various organs, the growing plant is continually producing new organs which would require immunisation. Since disease is abnormal physiology, little further progress will be made in the elucidation of the nature of plant diseases without further knowledge of the normal physiological processes of the associated organisms.

On the occasion of the Prince of Wales's recent visit to the Australian Commonwealth, he was presented by the State of Queensland with a gold-mounted casket of Queensland beanwood containing a collection of the gemstones for which the State is famous. In the *Queensland Naturalist* (vol. 3, No. 1) Mr. B. Dunstan, the Government geologist, describes the twenty-nine stones in the collection, giving the details of the provenance of each, and a general account of their properties and distribution throughout the State.

The *Museums Journal* for October contains a paper by Mr. L. H. Weston Klingender—who until the outbreak of war was curator of the Goslar Museum—on the organised co-operation of museums in Germany. There has long been talk in our own country of a closer union between the larger and smaller museums, and this interesting article should be of practical use to those who are considering such a scheme. The number also contains an appreciative notice of the late Dr. Henry Woodward from the museum point of view, and a critical but friendly account of the Association générale des Conservateurs des Collections publiques de France.

In *Science Progress* for January last the case for the inheritance of acquired characters was presented by Prof. E. W. MacBride. The challenge thus thrown down has been accepted by Mr. Julian S. Huxley, who states with considerable force in *Science Progress* for October the case for the chromosome theory of heredity advocated by Prof. Morgan and his school. Mr. Huxley summarises the evidence on which the theory is based and the bearings of recent work on the hypothesis, and points out certain implications of the theory which are not usually dealt with in the text-books. He is in whole-hearted agreement with Prof. Morgan, and believes that his theory of heredity is the only one which allows of the synthesis into one harmonious whole of the many, and apparently antagonistic, results of recent work in genetics, cytology, and experimental physiology and zoology.

The *Journal of Pomology* (vol. 2, No. 4, August, 1921), published by Messrs. Bunyard, Maidstone, contains the reproduction of a very scarce work entitled "The Orchard and Garden," published anonymously in 1602. For many years only one copy was known to exist, that being in the Cambridge University Library, but recently a second copy came to light, and was secured for the Lindley Library of the Royal Horticultural Society. The importance of choosing suitable soil and locality is emphasised, and grafting is treated at considerable length, both from like to like and "with contrary kindes." Among the divers sicknesses which affect the trees are canker and all kinds of caterpillars; for the former excision is recommended, for the latter diligent searching for the eggs which "lie hidden in a cobbwebbe," which should be burned, for "the fire consumeth all things." In a

short article in the same number by E. Richmond Swales, entitled "Apple Canker: Two Centuries' Practice in its Control," the writer suggests that we cannot claim to have improved upon the practice of two hundred years ago, namely, the clean cutting out of every canker spot and the treating of a fatally cankered tree as fit for nothing but the fire.

FEW of our readers, and certainly none who have any knowledge of the recent advances made in the subject of ballistics, would be disposed to dispute Dr. G. F. Hull's statement that the solution of the present-day problems of ordnance depend "on the applications of the precise experimental methods of modern physics." As a member of the technical staff of the chief of ordnance at Washington, Dr. Hull has had exceptional opportunities of watching the rapid progress of the last few years, and the reprint of his address to the engineering section of the Franklin Institute on the applications of physics to ordnance problems, which appears in the September issue of the journal of the institute, is the most public statement which has been made of facts hitherto regarded as profound secrets. Dr. Hull shows how the pressure within a gun during discharge may be measured by the electric charge it generates on crystals—piezo-electricity—and how the flight of the projectile can be followed by its electromagnetic effect on coils through which it passes, and in both cases the measurements may be made with an accuracy unattainable by the older methods.

AN interesting paper by Prof. G. Urbain on "The Energetic Bases of the Atomic Theory" appears in the *Revue Scientifique* of October 8. Some results may be obtained equally well from energetics and from the atomic theory, although the points of view adopted are different. The energetic conditions necessary for a molecular theory are examined and thermo-elastic and magnetic phenomena considered. The term "homeömerism," on the analogy of "isomerism," is introduced to denote the existence of groups of substances of different composition which have at least one series of differential coefficients identical. The laws of Raoult may be summarised in the statement that isotonic solutions in the same solvent are thermo-elastically homeömeric. Prof. Urbain's point of view is in many ways novel and interesting.

IN the *Journal of the Society of Glass Technology* for August, Mr. J. R. Clarke discusses the effect of rays from radium, X-rays, and ultra-violet light on glass. The α- and β-rays alone were productive of coloration in the glasses examined, which contained various metallic oxides. The colouring is supposed to be due to the formation of colloidal particles in the glasses, the presence of which may be explained by the action of the two kinds of rays on dissociated ions already present in the glasses. Fluorescence is held to be due to mechanical bombardment of the glass molecules by the rays.

THE July issue of the Journal of the Chemical Society contains a communication by E. C. C. Baly, I. M. Heilbron, and W. F. Barker on the photo-synthesis of formaldehyde and carbohydrates from carbon dioxide and water. An aqueous solution of carbon dioxide yields formaldehyde when exposed to radiation of wave-length 200$\mu\mu$. Polymerisation occurs, with formation of reducing sugars, in light of wave-length 290$\mu\mu$. Substances were found which increased the yield of formaldehyde by protecting it from polymerisation. The photosynthesis of formaldehyde from carbon dioxide and water is catalysed by certain coloured basic substances such as colloidal uranium and ferric hydroxides, malachite-green, and methyl-orange. Photosynthesis then takes place in visible light. Chlorophyll appears to be an ideal photocatalyst for both stages of carbohydrate synthesis from carbon dioxide and water, and its function in green plants is made clear by these investigations, which throw a good deal of light on a matter which has long been obscure.

THE shipbuilding returns for the quarter ending September 30 have just been published by *Lloyd's Register*, and are commented upon in the *Engineer* of October 14. After making allowance for vessels upon which work has been suspended, a total of 2,095,000 tons under construction in the United Kingdom is obtained. For the quarter under review the tonnage commenced amounted to only 51,343 tons, a decrease of 455,000 tons as compared with the last quarter of 1920. This is perhaps the most significant figure in the return as indicating the very unfavourable outlook for the immediate future. At the present time there are under construction throughout the world 140 vessels of more than 1000 tons for the carriage of oil in bulk, with a total tonnage of 931,813 tons. Of these, 81 are under construction in the United Kingdom, making an aggregate of 527,791 tons, and 28 totalling 222,292 tons in the United States. The tonnage of vessels under construction which are to be fitted with internal combustion engines amounts to 405,941 tons.

THE Journal of the British Science Guild for October contains the annual report of the executive committee and a summary of the proceedings at the annual meeting held in June last. References are made to the deaths of Sir Norman Lockyer, the distinguished founder of the Guild, and Sir William Mather, a trustee and original member, both of whom rendered valuable services extending over many years. The journal contains the addresses delivered at the annual meeting by the president (Lord Montagu of Beaulieu) and by Dean Inge, who emphasises the value of the forces of science and religion in promoting a solution of present industrial problems. An interesting summary is given of a recent series of articles by the president on road reform, and Sir R. A. S. Redmayne contributes a suggestive article on the importance of research in the development of the mineral industries. Among recent activities of the Guild may be mentioned the preparation of a catalogue of British scientific and technical books, comprising more than 6000 titles. We observe that attention continues to be devoted to the utilisation of science in public departments, in

which connection the control and administration of the Post Office is discussed. An important recent step has been the development of local branches or groups in the chief provincial cities, which will doubtless be of value in extending the Guild's sphere of usefulness. The main part of an address, entitled "The Message of Science," delivered by Sir Richard Gregory before the British Association, is reproduced as likely to be of service to organisers of provincial groups.

MESSRS WHELDON AND WESLEY, LTD., 38, Great Queen Street, W.C.2, have just issued a most useful botanical catalogue (New Series, No. 2), containing particulars of upwards of 3000 second-hand works offered for sale by them. The catalogue is very conveniently classified under the following headings, making reference easy: Early gardening, early herbals, modern gardening, cacti and succulents, flower garden and fernery, roses, fruit and vegetable garden, grape vine and wine, greenhouse and hothouse, landscape gardening and planting, orchids, plant breeding, etc., early agriculture and husbandry, modern British agriculture, grasses, forage plants, and weeds, livestock, tropical and foreign agriculture and gardening, food plants, beverages, etc., forestry and timber, industrial plants, medical botany, and addenda.

Our Astronomical Column.

THE TOTAL SOLAR ECLIPSE OF SEPTEMBER, 1922.—Prof. Campbell announces in *Popular Astronomy* for October that it is proposed to send an expedition from the Lick Observatory to Wollal, in West Australia, to observe this eclipse. The difficulties of landing are considerable, but not insuperable, and the prospects of good weather are better there than at any other station. The principal item on the programme is the Einstein problem. In order to shorten the necessary stay at Wollal it is intended to take comparison plates of the eclipse field at Tahiti on the voyage out, its latitude being nearly the same as that of Wollal. Another star field, culminating at night, will be photographed at both stations, to strengthen the basis of comparison.

RUBIDIUM IN THE SUN.—Dr. M. N. Saha predicted that the lines of rubidium might be detected in sunspot spectra, though invisible in the ordinary solar spectrum owing to considerable ionisation, which is less in the sunspot, where the temperature is lower. Prof. H. N. Russell has examined some fine spot spectra photographed with the 150-ft. tower telescope at Mount Wilson. He finds the two principal rubidium lines at 7800·29 and 7947·64 distinctly visible, the agreement in position being exact, and the relative strength being also in accord. He therefore considers the presence of rubidium established, and notes that the lines of sodium and potassium are also strengthened in the spot spectrum, from a similar reason.

COMETS.—Mr. Innes and Mr. Wood obtained numerous observations both of Encke's and Pons-Winnecke's comets at the Johannesburg Observatory during July and August. Those of Encke are printed in *Astr. Nach.*, No. 5123. Even by August 8, only twenty-six days after perihelion, the comet had become extremely faint, and it was looked for in vain on August 22 and 23. It has frequently been observed that this comet is more difficult to observe after perihelion than before it. The sun's heat appears to produce a rapid expansion of the coma, rendering it ill-defined.

Dr. W. Baade, of Bergedorf Observatory, obtained a photographic observation of Reid's comet on October 1d. 15h. 3m. 54s. G.M.T., its position referred to the equinox of 1921·0 being R.A. 8h. 27m. 39·38s., N. decl. 30° 11′ 19·5″; the magnitude was 14, and the indicated correction to Mr. Ebell's ephemeris was −19s., −3·2′. This observation, made six and a half months after discovery, will be of use in correcting the orbit elements.

FINDING OF THE MINOR PLANET ALINDA.—The search for this very interesting planet was referred to in NATURE for October 20. *Astr. Nach.* Circ., No. 32, states that the planet has been found at the Königstuhl Observatory. The following observations were made (referred to equinox of 1921·0):—G.M.T. October 10d. 14h. 1·2m., R.A. 3h. 0m. 7·15s., S. decl. 6° 35′ 58·1″, mag. 14·0; G.M.T. October 12d. 14h. 33·4m., R.A. 3h. 0m. 32·96s., S. decl. 7° 0′ 52·0″, mag. 13·8. Stracke's value of the mean daily motion requires the correction of +0·74″, which is satisfactorily small. The planet is likely to be followed for several months, as its linear motion in perihelion is nearly the same as that of the earth. During some revolutions of this planet the Jupiter perturbations will be large, and it will be of interest to investigate the alteration of the perihelion distance, which has the value 1·182, very little greater than that of Eros.

OBSERVATIONS OF VARIABLE STARS.—Mr. W. J. Luyten has published, as a thesis for his doctor's degree, the results of observations of variable stars made by him at Deventer and Leyden during the years 1915–19. His equipment gradually increased from a field-glass and a 3-in. telescope to the 6-in. equatorial at Leyden. His vision is unusually acute, and he could observe stars down to magnitude 13·7 with the 3-in. and to 14·8 with the 6-in. The stars observed include all types of variables; in the case of Algol stars nothing was attempted beyond the time of minimum, the light-curve being derived with much greater accuracy from the use of the photo-electric cell; but light-curves were found for the Cepheids, the note being made that minor fluctuations in the curves are found in the case of S Sagittæ only. New periods and formulæ are given for many of the long-period variables. ζ Geminorum is found to conform exactly with a sine-curve, the mean magnitude being 3·938 and the amplitude 0·165. In the case of SU Cygni, Luizet's period is shortened by 0·000151d. to 3·845472d. It is noted that there is a great discordance in the interval from maximum to minimum found by different observers.

Several stars are then discussed for which Prof. Turner and others had suggested sudden changes of period or of phase. Mr. Luyten's conclusions are more in favour of slow progressive change of period than of sudden jumps. He states that the observations and discussions will subsequently be published at greater length in *Annalen van de Sterrewacht te Leiden*.

Cambridge and Women.

IT is well to place on record here the nature of the concession to the cause of the education of women for which the Senate of the University of Cambridge voted on October 20:—

"The University shall have power to confer by diploma Titles of Degrees in any faculty upon students of a recognised institution for the higher education of women, who have done all that is required of them by the Statutes and Ordinances of the University. . . . The University *may* also admit members of such recognised institutions to instruction in the University as well as to the use of its libraries, laboratories, and museums, and it shall have power to determine the numbers to whom and the conditions on which any or all of these privileges shall be granted."

The granting of titular degrees to past and present students of Girton and Newnham Colleges does remove one real grievance from which these students have suffered in the educational world. The Old Guard at Cambridge, with their numerous supporters outside, have at last reached the position held by more enlightened members of the University four-and-twenty years ago. In that there is some hope. Possibly in another twenty-four years some such scheme as the compromise recently worked out in the University may pass the Senate in its turn. Or perhaps ere that government of the University by the University for the University will have become possible.

The women's colleges have announced their intention of renewing their appeal (suspended until the recent vote had been taken) to the Royal Commission at present sitting on Oxford and Cambridge Universities. They will, of course, be heard, and not much doubt is entertained as to the result. The women stand to gain a better position in the University from Parliament than the Cambridge Senate is prepared to grant them. Like the Nonconformists in the last century, they will have to be forced upon the University, as they rightly refuse to accept the suggestion that they can go elsewhere. Once they are inside, Cambridge will assimilate them as she has absorbed new constituent members in the past, and Cambridge will gain strength by them as she has gained from her other late-comers. The pity of it is that Cambridge should hold out so obstinately against this development, and that her successful resistance should have been marked by an outburst of disgraceful behaviour on the part of some of her young and thoughtless sons.

Aerial Photography.

THE annual Traill-Taylor lecture was delivered at the Royal Photographic Society's house on October 11, by M. L.-P. Clerc, who chose "Aerial Photography and Photo-topography" for his subject. M. Clerc is an acknowledged authority on this topic, since for practically the whole period of the war he was one of the moving spirits in connection with photography in the French Army, and for many years before this he was a recognised authority on both practical and scientific photography. The lecturer sought to avoid dealing with such subjects as have already been treated of by others, but spoke of many matters that are of prime importance in such work, and interesting, though affecting to a less degree, perhaps, photography of the more usual kinds.

Sufficient attention has not, so far, been paid to the effects of such low temperatures as are likely to be experienced at convenient heights for topographical work. A fall from 75° F. to zero increased the focal length of a lens of 21-in. focal length by one-half per cent. The effect of this is aggravated by the contraction of the camera body, which if of metal might be as much as half a millimetre, and so an appreciable error is introduced.

Although the importance of light-filters to reduce or eliminate the effect of atmospheric haze was recognised by the German army from the beginning of the war, M. Clerc spent more than three years without fully convincing the staff of the French Air Force of the necessity for them. Nor was the Force supplied with panchromatic plates, which, of course, are necessary when a deeply coloured filter is employed.

Practically all the cameras used by the various armies had focal plane shutters, but these suffered from grave defects. The blind was generally too far from the plate, and the ordinary motion of a high-speed aeroplane would cause elongation, compression, or torsion of the image during the tenth of a second usually necessary for the blind aperture to pass over the plate (whole-plate size), and the error of location of a point on the ground might be more than 15 ft. A between-lens shutter to give three or four thousandths of a second at 60 per cent. efficiency with a lens of 3-in. diameter, would require a movement of the leaves at the rate of about 140 ft. a second, which is practically impossible. It was therefore necessary to improve the performance of the focal-plane shutter, and many devices which were more or less successful are described.

The lecturer dealt also with the relative advantages of plates and roll-films (cut films being out of the question as embodying the disadvantages of both), the construction of cameras, their suspension from the aeroplane, and the orientation of the image. The use of metal sheaths for plates is condemned because of the uncertainty of the position of the sensitive surface. It is insisted that the mechanism for plate changing must be as automatic as possible, but without intricate and delicate parts which will not stand rough treatment. M. Clerc is a strong advocate of the desensitisation of the plates before development by Lüppo-Cramer's process, as it greatly facilitates visual control, and this is very desirable in order to balance duly the getting of density and the avoidance of too much fog from the effect of the atmospheric haze. This process was actually adopted by the French and Japanese armies. In due time the lecture will be published in full in the society's journal.

University and Educational Intelligence.

CAMBRIDGE.—Dr. T. S. Hele, Emmanuel College, and Dr. R. A. Peters, Gonville and Caius College, have been appointed University lecturers in biochemistry; and Mr. A. Berry, King's College, has been re-appointed University lecturer in mathematics.

The Raymond Horton-Smith prize has been awarded to Mr. A. G. Evans, Trinity College.

The regulations for the examination for the diploma in psychological medicine have been published.

LONDON.—At a meeting held on October 19 the Senate considered a communication from the London County Council inviting the Senate to explore the possibilities of the Holland Park Estate as a site for London University before further action is taken in the Bloomsbury proposal.

In the reply which was eventually adopted, it was stated that with the degree of approval of the

Bloomsbury site on the part of the educational authority for London, indicated by the promise of financial support up to a third of a million pounds, the Senate felt justified in accepting the Government's offer. The contracts for sale were completed in January last, and the actual conveyance to the commissioners of the Office of Works is dated March 23. Moreover, a portion of the site is already occupied by the Institute of Historical Research, which has been presented by an anonymous donor to the University at a cost of about 20,000*l.*, and has been accepted by the Senate. The question of site can, therefore, scarcely be reopened with the Government on the initiative of the Senate, but, should the Government wish to explore the possibilities of the Holland Park site, or any other site in conjunction with the University, the Senate would be prepared to co-operate.

The Senate has made the following appointments :— Dr. W. B. Tuck to the University chair of chemistry, tenable at Middlesex Hospital Medical School; Dr. Paul Haas to the University readership in plant chemistry, tenable at University College; Rev. F. A. P. Aveling to the University readership in psychology, tenable at King's College: Mr. W. E. Curtis to the University readership in physics, tenable at King's College.

The thanks of the Senate have been accorded to the Worshipful Company of Drapers for their renewal for a further period of three years of their grant of 500*l.* a year to the Department of Applied Statistics and Eugenics at University College.

Dr. Charles Bolton, of the Graham Research Laboratories at University College Hospital Medical School, has been awarded the William Julius Mickle Fellowship of 200*l.* in recognition of the important work in experimental medicine which he has carried out during the past five years.

The following doctorates have been conferred: *D.Sc. in Chemistry:* Mr. C. K. Ingold, an internal student, of the Imperial College, Royal College of Science, for a thesis entitled "The Formation and Stability of Carbon Rings"; *D.Lit.:* Miss K. M. Westaway, an external student, for a thesis entitled "The Educational Theory of Plutarch"; *D.Sc. in Chemistry:* Mr. Harry Hepworth, an external student, for a thesis entitled "Some New Researches on the Grignard Reagent and other Matter"; *D.Sc. in Engineering:* Mr. Hubert Mawson, an external student, for a thesis entitled "Analytical and Experimental Investigations relating to Centrifugal Pumps and Water Turbines," and other papers; *D.Sc. in Economics:* Mr. James Stephenson, an external student, for a thesis entitled "The Manufacturers' Agent: His Economic and Social Significance," and other papers.

ST. ANDREWS.—Mr. H. W. Turnbull has been appointed Regius professor of mathematics in succession to Sir Peter Scott Leng, who has resigned.

THE University College of Wales, Aberystwyth, is to receive from Sir Garrod Thomas a gift of lands estimated to be worth 8000*l.*, the income from which is to be devoted to the encouragement of post-graduate work in chemistry and physics.

THE *British Medical Journal* of October 15 announces that Prof. Léon Fredericq is to be presented with a medallion in recognition of his distinguished services as professor of physiology for fifty years in the University of Liège. The presentation will take place in November, when his son will take the chair which Prof. Léon Fredericq has held so long.

Calendar of Scientific Pioneers.

October 27, 1675. Gilles Persone de Roberval died.—An original member of the Paris Academy of Sciences, Roberval held the chair of mathematics in the Collège Royal, was an early writer on the method of indivisibles, and discussed the nature of the tangent and cycloid.

October 27, 1845. Jean Charles Athanase Peltier died.—Remembered for his discovery of the "Peltier effect," Peltier was a French watchmaker who retired from business to carry out researches in experimental physics.

October 27, 1905. Frederick Wollaston Hutton died.—With Hector, von Haast, and Hochstetter, Hutton assisted to lay the foundation of the geology of New Zealand. A soldier by profession, he served in the Crimea and the Indian Mutiny, but ultimately became a professor in Christchurch University.

October 28, 1703. John Wallis died.—After rendering valuable service to the Puritans during the Civil War, Wallis in 1649 was appointed Savilian professor of geometry at Oxford, a post he held until his death. His "Arithmetica Infinitorum" contained the germs of the differential calculus.

October 28, 1916. Cleveland Abbe died.—Foremost among American meteorologists, Abbe was first an assistant in the observatories at Pulkowa and Washington, and then director of that at Cincinnati, where in 1869 he organised meteorological reports from which sprang the United States Government Weather Service.

October 29, 1783. Jean le Rond D'Alembert died.—The intimate friend of Voltaire and Diderot, D'Alembert was admitted to the Paris Academy of Sciences in 1741, and in 1772 became perpetual secretary. With Clairaut and Euler he is regarded as one of the greatest mathematicians of the eighteenth century. His "Traité de dynamique," containing the famous principle, appeared in 1743, his "Système du Monde" in 1754.

October 30, 1626. Willibrord Snell van Roijan died.—The discoverer of the law of refraction of light and the first to measure an arc of meridian by triangulation, Snell, or Snellius, was a professor of Leyden, where in 1613 he succeeded his father in the chair of mathematics.

October 31, 1858. Sir William Reid died.—A military engineer, Reid, when stationed in Barbados, propounded the circular theory of hurricanes, and in 1838 published "An Attempt to Develop the Law of Storms."

October 31, 1867. William Parsons, Earl of Rosse, died.—Resigning his seat in Parliament, Rosse from 1834 devoted himself to science, and in 1845 completed the great 6-ft. reflector at Parsonstown, with which many discoveries were made. From 1848 to 1854 he was president of the Royal Society.

November 1, 1915. Sir Arthur William Rücker died.—Rücker rendered valuable service to scientific education as a professor and administrator in Leeds and in London, while as an investigator he took a leading part in the magnetic survey of the British Isles.

November 2, 1905. Rudolph Albert von Kölliker died.—Of Swiss birth and descent, Kölliker passed most of his life in Germany, and from 1847 held the chair of physiology and of microscopical and comparative anatomy at Wurzburg. He greatly improved microscopical technique, and especially enriched histology. In 1897 he was awarded the Copley medal of the Royal Society. E. C. S.

Societies and Academies.

LONDON.

Aristotelian Society, October 10.—Dr. F. C. S. **Schiller**, president, delivered an inaugural address: Novelty. Novelty is an all-pervasive psychical fact. Every mind has a history which never quite repeats itself, and this history affects its apprehension. The same is true of all reality: its flow sets in one direction only, and is irreversible. The past is irrevocable and the future never exactly calculable, history is therefore always relevant to essence. The method of history at first sight seems to imply a denial of novelty. The new is *explained* by taking it as a case of the old. It has to be taken thus to be controlled. But the abstraction is essentially a fiction and leads to a subsequent recognition of the new and a modification of the old "law" by the new "case." Thus the negation of novelty in scientific method is only provisional and methodological. The philosophic sciences also are not really pledged to a different procedure. Logic must recognise novelty, if reason is not to be divorced from reasoning and reasoning to become unmeaning. "Novelty or Nullity" is the first law of thought, if thought is admitted to presuppose thinking. Metaphysics has ancient prejudices against novelty, as involving *change*. It assumes that Being must be a constant quantity. Yet its notion of Being is only an hypothesis, and abstractly there are the possibilities that it may increase or diminish. Empirically the former seems exemplified in psychic being, the latter in physical. The existence of novelty means creation out of nothing. This conception has long been among the paradoxes which the Christian religion affirmed in spite of philosophy and science and language. Yet the conception has religious value, for a world of which the being is constant cannot change for the better because it cannot change at all. Valuations are not only facts themselves, but the ultimate determinants of all the facts we recognise.

PARIS.

Academy of Sciences, October 10.—M. Léon Guignard in the chair.—E. L. **Bouvier** and R. **Roidor**: The appearance of males and females in the nests of the field-ant (*Formica pratensis*) and the tawny ant of the Upper Jura (*F. rufa*). In the study of seventeen ants' nests during June, most of the anthills produced winged ants, but only one sex from each nest. For *F. rufa* the unisexual period is followed by another, during which both sexes come out.—M. **Tilho**: The Franco-Anglo-Egyptian frontier and the line of the watershed between the basins of the Nile and Lake Tchad. A sketch of the work before the British and French Boundary Commissions, and of the application of wireless telegraphy by the latter for the purpose of rapid and accurate surveying.—L. **Fabry**: The atmospheric wave produced by the explosion of the works at Oppau. The seismograph at Marseilles Observatory registered no vibration; the barograph curve showed a sudden variation of 0·5 mm. at 8.4 a.m. (Greenwich time) which might have been due to the explosion.—T. **Varopoulos**: Increasing functions.—P. **Fatou**: Functions admitting several theorems of multiplication.—G. **Valiron**: The Picard-Borel theorem in the theory of integral functions.—J. **Chazy**: Stability in the problem of three bodies.—C. **Nordmann**: Intrinsic brightness and the effective "diameters" of stars. Remarks on a recent publication of J. Wilsing on this subject. The author published results based on a similar method in 1910, and these are tabulated alongside the figures given by Wilsing. The two are in good agreement.—J. **Duclaux** and P. **Jeantet**: The absorption spectrum of oxygen. Details are given for the portion of the spectrum between 1900 and 2000 A.U.—A. **Damiens**: Tellurium subbromide. The existence of $TeBr_2$ in the gaseous state was pointed out in a previous communication; it has now been isolated by suddenly cooling the vapour to −80° C. The lower bromide is unstable and hygroscopic.—M. **Grandmougin**: The constitution of the polysulphonated derivatives of indigo.—G. **Andoyer**: Determination of the added water and fat removed in samples of decomposed milk.—E. **Fournier**: The *rôle* of pre-existing fissuration in the tectonic flexibility of hard rocks and in the formation of mylonites.—A. **Guébhard**: The true "directing lines" of terrestrial orogeny.—H. **Ricôme**: Curvilinear growth.—H. **Coupin**: The contribution of the seed to the adult plant. This varies with the plant; it is considerable in some (bean, soya bean, peanut, pumpkin, and nasturtium), small in the pea, and very small in lucerne, artichoke, radish, tomato, and many other plants.—J. **Legendre**: Anophelism and rabbit-breeding. *A. maculipennis* shows a marked preference for the rabbit over any other animal, and the author concludes that rabbit-breeding gives efficacious protection against European malaria transmitted by this mosquito.—L. **Bertin**: The extreme variability of the Roscoff stickleback (*Gasterosteus aculeatus*).—C. **Michailesco**: Experimental researches on the variations of sensibility of the blind spot.—E. **Rabaud**: Tropisms and muscular tonus.—L. M. **Betances**: The chromophilia of the granulation known as *azurophile*.—E. F. **Terroine** and H. **Barthélémy**: Composition of the egg of the brown frog (*Rana fusca*) at the egg-laying period. The composition of the egg of *R. fusca* is independent of the age or weight of the individual.—F. **Fremiet** and Mlle. du Vivier **de Streel**: The chemical composition of the egg and of the tadpole of *Rana temporaria*.—MM. **Desgrez**, **Guillemard**, and **Hemmerdinger**: Individual protection against carbon monoxide: reagent and apparatus. Details of the preparation of the mixture of iodine pentoxide and sulphuric acid used as absorbent and of the respirator in which it is used.—G. B. **de Toni**: The leaves torn from the E manuscript of Leonardo da Vinci, preserved in the library of the Institute. The Venturi manuscripts at the library of Reggio-Emilia contain three volumes of transcriptions of the da Vinci manuscripts. From these it is possible to reconstruct, at least in part, the E manuscript and others of da Vinci preserved at the Institute.

WASHINGTON, D.C.

National Academy of Sciences, Proceedings, vol. 6, No. 9. September, 1920.—P. W. **Bridgman**: Further measurements of the effect of pressure on resistance. The new evidence corroborates the point of view that for most elements the most important feature in determining the variations of electric resistance is the amplitude of atomic vibration.—W. **Duane** and R. A. **Patterson**: Characteristic absorption of X-rays, L series. Three critical absorption wave-lengths were found for each of the nine elements examined, and a brief discussion of the bearing of these results on certain empirical laws in recent years is given.—W. **Duane** and R. A. **Patterson**: On the relative positions and intensities of lines in X-ray spectra. New experiments with a discussion as to the light they throw upon the constitution of the atom.—H. **Bateman**: On a differential equation occurring in Page's theory of electromagnetism.—J. R. **Kline**: A new proof of a theorem due to Schoenflies.—S. J. **Meltzer**: Are the superior cervical ganglia indispensable to the

maintenance of life? In 90 per cent. of the animals used the removal of both ganglia proved fatal, and the evidence seems to be that the death of the animals was not due to the procedure of the operation, but to the fact that the ganglia are essential to the maintenance of life.—M. **Kriss**: Observations on the body temperature of dry cows.—S. D. **Zeldin**: On the structure of finite continuous groups with exceptional transformations.

CAPE TOWN.

Royal Society of South Africa, August 17.—Dr. J. D. F. Gilchrist, president, in the chair.—H. G. **Denham**: Note on the bismuth sub-salts. The basic oxalate of bismuth, when heated to 300° under reduced pressure, yields bismuth suboxide BiO. When the vapour of methyl iodide is distilled through this suboxide at 260°, a basic subiodide, $2BiI_2$, $3BiO$ is obtained—a reddish, insoluble powder of considerable reducing power. Outside the oven bright red, orthorhombic crystals of bismuth subiodide, BiI_2, separated out. Both salts are quite stable in dry air, but readily oxidise in the pressure of moist oxygen.—S. H. **Skaife**: On variation and heredity in the Bruchidæ. Breeding experiments with beetles of the family Bruchidæ. A mutation was found in *Acanthoscelides obtectus*, which was lacking in pigment; lack of pigmentation is recessive. Attempts to hybridise Chinensis and Quadrimaculatus were unsuccessful. Interspecific crossing is prevented among the Bruchidæ by differences in the size, shape, and structure of the internal sacs of the males.

Books Received.

Home Carpentry and Cabinet-Making. By F. W. Lewis. Pp. x+170. (London: G. Routledge and Sons, Ltd.; New York: E. P. Dutton and Co.) 3*s*. 6*d*. net.

Practical Physiological Chemistry. By Dr. J. A. Milroy and Prof. T. H. Milroy. Third edition. Pp. ix+449+2 plates. (Edinburgh and London: W. Green and Son, Ltd.) 21*s*. net.

Elementary Statics of Two and Three Dimensions. By Prof. R. J. A. Barnard. Pp. vii+254. (London: Macmillan and Co., Ltd.) 7*s*. 6*d*.

An Abstract of the Legislation in Force in the British Empire dealing with Plant Pests and Diseases up to the Year 1920. Compiled by M. Ralfs. Pp. 65. (London: Imperial Bureau of Entomology.) 2*s*. 6*d*. net.

Dove Marine Laboratory, Cullercoats, Northumberland. Report for the Year ending June 30, 1921. Edited by Prof. A. Meek. Pp. 111. (Newcastle-upon-Tyne: Armstrong College.)

A Critical Revision of the Genus Eucalyptus. By J. H. Maiden. Vol. 5, Part 8. (Part 48 of the complete work.) Pp. 223–61+plates 196–99. (Sydney: W. A. Gullick.) 3*s*. 6*d*.

Uber Äther und Uräther. By P. Lenard. Pp. 56. (Leipzig: S. Hirzel.) 9 marks.

Die Einsteinsche Gravitationstheorie: Versuch einer Allgemein Verstandlichen Darstellung der Theorie. By Prof. G. Mie. Pp. iv+67. (Leipzig: S. Hirzel.) 7 marks.

Introduction to the Study of Minerals and Guide to the Mineral Collections in the Kelvingrove Museum. By Prof. P. Macnair. Second edition. Pp. viii+94. (Glasgow: Hay Nisbet and Co., Ltd.) 1*s*.

Mind and its Disorders: A Text-book for Students and Practitioners of Medicine. By Dr. W. H. B. Stoddart. Fourth edition. Pp. xvi+592. (London: H. K. Lewis and Co., Ltd.) 22*s*. 6*d*. net.

Among the Hill Folk of Algeria: Journeys among the Shawía of the Aurès Mountains. By M. W. Hilton-Simpson. Pp. 248. (London: T. Fisher Unwin, Ltd.) 21*s*. net.

Office Scientifique et Technique des Pêches Maritimes. Notes et Mémoires No. 7: Résumé de nos principales connaissances pratiques sur les Maladies et les Ennemis de l'Huître. By R. Ph. Dollfus. Pp. 47. (Paris: Ed. Blondel La Rougery.) 3 francs.

Type Ammonites. By S. S. Buckman. Part 29. Pp. 49–54+16 plates. (London: Wheldon and Wesley, Ltd.)

Practical School Gardening. By P. Elford and S. Heaton. Second edition. Pp. 224. (Oxford: Clarendon Press.) 3*s*. 6*d*. net.

Experimental Researches and Reports. Vol. 3, 1919–20: Collected from "Journal of the Society of Glass Technology," "Journal of the American Ceramic Society," and "Reports of the Progress of Applied Chemistry" issued by the Society of Chemical Industry. Pp. iii+180. (Sheffield University: Dept. of Glass Technology.)

Hermann v. Helmholtz Schriften zur Erkenntnistheorie. Edited by Paul Hertz and M. Schlick. Pp. x+175. (Berlin: J. Springer.) In Germany, 45 marks; in England, 90 marks.

Confectioners' Raw Materials: Their Sources, Modes of Preparation, Chemical Composition, the Chief Impurities and Adulterations, their More Important Uses and other Points of Interest. By James Grant. Pp. viii+173. (London: E. Arnold and Co.) 8*s*. 6*d*. net.

Hormones and Heredity: A Discussion of the Evolution of Adaptations and the Evolution of Species. By J. T. Cunningham. Pp. xx+246. (London: Constable and Co., Ltd.) 24*s*.

The Rainfall of the British Isles. By M. de Carle S. Salter. Pp. xiii+295. (London: University of London Press, Ltd.) 8*s*. 6*d*. net.

The Institution of Civil Engineers. Engineering Abstracts prepared from the Current Periodical Literature of Engineering and Applied Science published outside the United Kingdom. New Series, No. 9. Pp. 230. (London: Institution of Civil Engineers.)

An Account of the Crustacea of Norway. By G. O. Sars. Vol. 8: Copepoda, Monstrilloida, and Notodelphyoida. Parts 1 and 2: Thaumatopsyllidæ, Monstrillidæ, Notodelphyidæ (part). Pp. 32+16 plates. (Bergen: Bergens Museum.)

Das Klima des Eiszeitalters. By Prof. Dr. R. Spitaler. Pp. iv+138. (Prag: Selbtsverlag.)

Metric System for Engineers. By C. B. Clapham. (The D.-U. Technical series.) Pp. xii+181. (London: Chapman and Hall, Ltd.) 12*s*. 6*d*. net.

A Popular Chemical Dictionary: A Compendious Encyclopædia. By C. T. Kingzett. Second edition. Pp. viii+539. (London: Baillière, Tindall and Cox.) 21*s*. net.

History of the Great War, Based on Official Documents. By Sir J. S. Corbett. Vol. 2. Pp. xi+448+17 plates. (London: Longmans, Green and Co.) 21*s*. net.

Memoirs of the Geological Survey of India. Palæontologia Indica. Vol. 3, Memoir No. 2. Plates 1–21. The Brachiopoda of the Namyan Beds, Northern Shan States, Burma. By S. S. Buckman. Pp. v+229+plates. (Calcutta: Geological Survey; London: Kegan Paul and Co., Ltd.) Rupees 5.4, or 7*s*.

Edina Geographies. Book 3: Asia. By T. Franklin. Pp. 63. (Edinburgh: W. and A. K. Johnston, Ltd.; London: Macmillan and Co., Ltd.) 1*s*. net.

The Chemistry of the Garden: A Primer for Amateurs and Young Gardeners. By H. H. Cousins. Revised edition. Pp. xxxi+147. (London: Macmillan and Co., Ltd.) 2s. net.

The Elements of Physics and Chemistry: A Practical Course for Middle Forms. By Sir Richard Gregory and A. T. Simmons, with the Assistance of F. W. Hodges. Pp. vii+299. (London: Macmillan and Co., Ltd.) 4s. 6d.

Diary of Societies.

THURSDAY, OCTOBER 27.

INSTITUTION OF MINING AND METALLURGY (at Geological Society's Rooms), at 5.30.—L. Hill: Ventilation and Human Efficiency.—J. N. Justice: Notes on the Orc Deposits of Eagle Mountain, Demerara.

CHILD-STUDY SOCIETY (at Birkbeck College), at 6.—Discussion on Individual Training in the School.—Miss Bassett: The Dalton Plan.—Miss Mackinder: Individual Work.—Mrs. Bottrill: Vertical Classification.

EGYPT EXPLORATION SOCIETY (at Royal Society Rooms), at 8.30.—P. E. Newberry: Early Relations of Egypt, Babylonia, and Syria.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—Presidential Address by Sir Thomas Horder: The Medical Aspect of Some Urinary Diseases.

FRIDAY, OCTOBER 28.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—S. Butterworth: On the Use of Anderson's Bridge for the Measurement of the Variations of the Capacity and Effective Resistance of a Condenser with Frequency.—S. Butterworth: Notes on Earth Capacity Effects in Alternating Current Bridges.—F. G. H. Lewis: An Automatic Voltage Regulator.—Prof. A. S. Hemmy: The Flow of Viscous Liquids through Slightly Conical Tubes.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Continuation of Discussion on the Eleventh Report of the Alloys Research Committee on Some Alloys of Aluminium.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.—Dr. L. G. Haydon: Plague in Wild Rodents in South Africa.

MONDAY, OCTOBER 31.

INSTITUTE OF ACTUARIES, at 5.—E. H. Lever: An Investigation into the Mortality experienced by Life Tenants under Reversions, with some Conclusions drawn therefrom.

TUESDAY, NOVEMBER 1.

MINERALOGICAL SOCIETY, at 5.30.—Anniversary Meeting.—Prof. H. Hilton: On the Determination of the Optic Axes of a Crystal from Extinction-angles.—Dr. J. Drugman: An Example of Quartz Twinned on the Sardinian Law.—Dr. L. J. Spencer: Biographical Notices of Mineralogists recently deceased, with an Index of those Previously Published in the *Mineralogical Magazine*.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Inaugural Address by the President, W. B. Worthington.

RÖNTGEN SOCIETY (at Institution of Electrical Engineers), at 8.15.—Prof. J. W. Nicholson: Presidential Address.

WEDNESDAY, NOVEMBER 2.

ROYAL SOCIETY OF ARTS, at 8.—A. A. Campbell Swinton: Wireless Telegraphy (Inaugural Address).

SOCIETY OF PUBLIC ANALYSTS (at Chemical Society's Rooms), at 8.—Dr. C. Butler Savory: An Improved Specific Gravity Apparatus.—Dr. J. C. Drummond and Dr. A. F. Watson: The Testing of Foodstuffs for Vitamins.—A. Lucas: The Inks of Ancient and Modern Egypt.

THURSDAY, NOVEMBER 3.

ROYAL SOCIETY, at 4.30.—Prof. T. R. Merton: On the Spectra of Lead Isotopes.—G. I. Taylor: Experiments with Rotating Fluids.—Prof. L. Bairstow, Miss B. M. Cave, and Miss E. D. Lang: The Two-dimensional Slow Motion of Viscous Fluids.—Prof. H. C. H. Carpenter and Constance Elam: The Production of Single Crystals of Aluminium and their Tensile Properties.—Prof. C. V. Raman and B. Ray: On the Transmission Colours of Sulphur Suspensions.—Prof. E. F. Burton and Miss E. Bishop: The Law of Distribution of Particles in Colloidal Solution.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—J. S. Highfield: Inaugural Address.

CHEMICAL SOCIETY, at 8.—Informal Meeting.

FRIDAY, NOVEMBER 4.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 5.—Col. H. G. Lyons, Prof. C. V. Boys, Col. E. H. Grove-Hills, and Col. Sir G. P. Lenox-Conyngham: The Eötvös Gravity Balance.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Dr. H. S. Hele-Shaw: Power Transmission by Oil (Thomas Hawksley Lecture).

PUBLIC LECTURES.

(A number in brackets indicates the number of a lecture in a series.)

THURSDAY, OCTOBER 27.

KING'S COLLEGE, at 5.30.—H. W. Fitz-Simons: Bridge Construction (2).

FRIDAY, OCTOBER 28.

UNIVERSITY COLLEGE, at 4.30.—Dr. J. C. Drummond: Nutrition (3).

MONDAY, OCTOBER 31.

BIRKBECK COLLEGE, at 5.30.—L. Bolton: Relativity (2).

KING'S COLLEGE, at 5.30.—H. Moore: Liquid Fuels (2).

TUESDAY, NOVEMBER 1.

KING'S COLLEGE, at 5.30.—Prof. H. Wildon Carr: The Modern Scientific Revolution and its Meaning for Philosophy (4).—Event and Object.—Dr. W. Brown: Psychology and Psychotherapy (3).—L. J. Hunt: Cascade Synchronous Motors and Generators (3).

WEDNESDAY, NOVEMBER 2.

UNIVERSITY COLLEGE, at 3.—Prof. E. G. Gardner: Nature in the *Divina Commedia* (Barlow Lectures on Dante).

KING'S COLLEGE, at 4.30.—Dr. C. Da Fano: Histology of the Nervous System (4). At 5.15.—Prof. A. Dendy: Fauna of the British Empire.

THURSDAY, NOVEMBER 3.

UNIVERSITY COLLEGE, at 5.—Prof. J. E. G. De Montmorency: Feudalism: The Background of the European System (1).

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—W. Bateson: Recent Advances in Genetics (1).

CHADWICK PUBLIC LECTURE (at Royal Institute of British Architects), at 8.—Prof. P. Groom: Dry Rot of Wood and Sanitation.

FRIDAY, NOVEMBER 4.

UNIVERSITY COLLEGE, at 4.30.—Dr. J. C. Drummond: Nutrition (4). At 8.—Prof. G. Dawes Hicks: Our Knowledge of the Real World (1).

CONTENTS.

	PAGE
A Tropical College of Agriculture	265
Cellulose Esters	266
History of Birds in Britain	268
Chromium, Platinum, and Lead Ores. By J. W. G.	268
The Phoenicians in Sicily	269
Our Bookshelf	270
Letters to the Editor:—	
Biological Terminology.—Dr. F. A. Bather, F.R.S.	271
Indian Land Mollusca.—Sir A. E. Shipley, G.B.E., F.R.S.	271
Safeguarding of Industries Act, 1921.—Prof. L. Bairstow, F.R.S., and Major A. G. Church	271
Aurora Borealis, Terrestrial Magnetic Disturbances, and Sun-spots.—Father A. L. Cortie, S.J.	272
Sex-change in the Native Oyster.—W. L. Calderwood	272
A Relation between the Combined Atomic Volumes and their Optical Refractivities. (*With Diagram.*)—Gervaise Le Bas	272
Hybridity and the Evolution of Species.—Prof. J. P. Lotsy; The Writer of the Article	274
A System of Space-Time Co-ordinates.—J. L. Synge	275
Aeroplane Photography for Archæology.—A. P. Trotter	275
Cosmic Friction: A Query.—Sir Oliver Lodge, F.R.S.	275
Muscular Piezo-electricity?—E. Wriothesley Russell	275
Speaking Films. (*Illustrated.*) By Prof. A. O. Rankine	276
The Oppau Explosion	278
The Age of the Earth. By The Right Hon. Lord Rayleigh, F.R.S.; Prof. W. J. Sollas, F.R.S.; Prof. J. W. Gregory, F.R.S.; and Dr. Harold Jeffreys	279
Obituary:—	
Dr. A. S. F. Leyton. By G. S. W.	284
Sir William Garforth	285
Notes	287
Our Astronomical Column:—	
The Total Solar Eclipse of September, 1922	291
Rubidium in the Sun	291
Comets	291
Finding of the Minor Planet Alinda	291
Observations of Variable Stars	291
Cambridge and Women	292
Aerial Photography	292
University and Educational Intelligence	292
Calendar of Scientific Pioneers	293
Societies and Academies	294
Books Received	295
Diary of Societies	296

THURSDAY, NOVEMBER 3, 1921.

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The Langley Flying Machine.

AT a recent meeting of the Royal Aeronautical Society a paper was read by Mr. Griffith Brewer on "The Langley Machine and the Hammondsport Trials," which has for its theme "the attempt to rob the Wright brothers of the credit of inventing the aeroplane."

The argument of the paper turns on a usual interpretation of the word "inventing," and it is not suggested that the credit of establishing the principles of aeroplane design is in doubt. The dispute as to the relative importance of the pioneers S. P. Langley and the Wright brothers arose in the course of certain legal actions as to the validity of patents taken out by the latter. In connection with the defence of the Curtiss Aeroplane Co. against a charge of infringement, arrangements were made with the Smithsonian Institution for the loan of the original man-carrying aeroplane designed and constructed by Langley. The design was modified in certain ways before it was taken into the air at Hammondsport, and the contention of Mr. Brewer in putting the case for the Wright brothers is that the modifications were such as to invalidate the claim that the original Langley aeroplane had been flown.

The trials of the modified aeroplane were made late in the development of the subject, the loan by the Smithsonian Institution being dated April, 1914. The public European flights of the Wright brothers had taken place some six years prior to this, whilst the date of the first successful flight of about one minute's duration is stated to be December, 1903. It is perhaps worth while to clear up the historical facts of the trials, but the paper tends to give an erroneous impression of the importance of the part played by the Wright brothers in spite of Mr. Brewer's note to the effect that Langley himself did not make the claims to which exception is taken, nor would he have been likely to do so had he been alive to hear of the controversy.

The difficulty appears to arise from a not uncommon type of mental blindness which is readily produced by the contact of financial interests with development. It is rather like making the assumption that, because an arch cannot be used as an engineering structure until the keystone is in place, the keystone is therefore the most important element in it; the rest of the structure appears to be unseen. Applied to Mr. Brewer's paper, the simile suggests that the keystone was provided by the Wright brothers, and that the much more laborious work of preparing for its reception is to be found in the scientific experiments of Langley. Readers of NATURE will find in its volumes references which indicate, in a calmer atmosphere, the part played by Langley in the development of aviation. So far back as July 23, 1891, a paper on his experimental researches is to be found in NATURE showing that the flight of a man-carrying aeroplane was possible, and enunciating the fundamental principles for obtaining a design. Matters were so much advanced in 1896 that on May 28 of that year NATURE was able to give a description of the flight of the Langley model aeroplane under its own power. This was a remarkable achievement, since it required a solution of the problem of inherent stability, a quality almost certainly not possessed by the Wright aeroplanes of 1908. The great addition to aeronautical knowledge and practice made by the Wright brothers was the introduction of the system of wing warping which gave adequate lateral control even to an unstable aeroplane.

Langley's researches have been described on many occasions, and their relation to the problem of dynamic flight is shown in Sir Richard Gregory's book, "Discovery," from which a couple of extracts may be appropriately cited as bearing directly upon the subject under discussion. On p. 288 Langley is quoted as saying, in relation to his experiments before 1897:—

"I have brought to a close the portion of the work which seemed specially mine—the demon-

stration of the practicability of mechanical flight —and for the next stage, which is the commercial and practical development of the idea, it is probable that the world may look to others. The world, indeed, would be supine if it does not realise that a new possibility has come to it, and that the great universal highway overhead is now soon to be opened."

The Wright brothers are equally clear in their acknowledgment of Langley's work :—

"The knowledge that the head of the most prominent scientific institution of America believed in the possibility of human flight was one of the influences which led us to undertake the preliminary investigations that preceded our active work. He recommended to us the books which enabled us to form sane ideas at the outset. It was a helping hand at a critical time, and we shall always be grateful."

One feels that in relation to such remarks by the two great American pioneers of aviation the matter under discussion in "The Langley Machine and the Hammondsport Trials" is unimportant. The transactions appear to have been rather sordid and to reflect discredit on those commercial systems of the world which exalt "patentability" at the expense of solid service which is not patentable.

The Impurity of Pure Substances.

Die Theorie der Allotropie. By Prof. A. Smits. Pp. xvi+500. (Leipzig: Johann Ambrosius Barth, 1921.) 100 marks.

AT one time the term allotropy or allotropism was confined mainly to the chemical elements, such as oxygen, carbon, phosphorus, etc. In one of these cases—that of oxygen and ozone—the explanation of the allotropic forms was found in the existence of different molecular species, whereas in the case of diamond and graphite, for example, this could not be definitely proved. Another more striking case of the latter sort is presented by the rhombic and monoclinic forms of sulphur. As our knowledge increased concerning the different crystalline forms, in which both elements and compounds could occur, the idea of crystalline polymorphism was developed. In these cases it was supposed that one and the same molecular species only was involved, that the polymorphism was due to different crystalline arrangements of the same units, and that the vapours or solutions derived from the different polymorphic forms would, for the same values of pressure, temperature, and concentration, be chemically and physically identical. This explanation certainly gave a satisfactory account of the main facts involved—that is to say, the various substances appeared to behave as *one-component* systems. The curious facts relating to the behaviour of water suggested, however, to chemists that this substance was in reality *complex,* water consisting at any given temperature and pressure of a mixture of molecular species differing in the degree of *association* of the simplest (Avogadrian) molecular type.

This idea of an inner complexity, or inner equilibrium of simple and associated molecules, was gradually extended to other classes of "pure" substances—that is to say, substances the thermodynamical behaviour of which was that of a one-component system. In spite of this inner complexity, it was realised that such substances would behave as one-component systems so long as, with variation of the "external" parameters (pressure, temperature, etc.), the inner equilibria were readjusted with a speed incomparably greater than the rate of variation of the parameters referred to. Cases gradually became known, however, where certain one-component systems exhibited a *pseudo-binary* character. Thus the researches of Alexander Smith, Aten, Kruyt, etc., on sulphur showed that liquid sulphur must be a mixture of different molecular species, for if the inner equilibrium existing at any given temperature were "frozen" (or partly so) by the use of certain inhibiting agents (so-called negative catalysts), liquid sulphur showed a marked pseudo-binary behaviour.

Such phenomena were easily understood owing to the knowledge possessed by chemists of the behaviour of nitrogen peroxide. Here there is a well-known inner equilibrium (of a simple and an associated form) existing not only in the pure liquid state, but also in the states of vapour and solution. The researches of Prof. H. B. Baker showed that the speed of readjustment of this inner equilibrium is positively catalysed by very minute traces of water, and that it may be "frozen" by very prolonged and intensive dehydration. We may, in fact, have at a given temperature and pressure an infinite number of different liquid or gaseous "nitrogen peroxides," the former one-component system passing thus into an infinite number of states corresponding to a two-component system.

About fourteen years ago Prof. Smits, on the basis of certain experimental results which he had obtained, took a very daring and interesting step. It occurred to him that perhaps all known cases of allotropy, phase-polymorphism, etc., were due to the existence of different inner equilibria of two or more different molecular species,

and that this applied not only to liquids, but also to solids. Thus the different crystalline forms were to be viewed as *solid crystalline solutions of two or more molecular species.* Bancroft had already shown that many curious phenomena in the behaviour of "pure" organic substances—such as the dependence of the melting-point on the rate of heating, in cases where no "ordinary" decomposition occurred—could be explained only by the existence of two different molecular species in the liquid, these species existing in inner equilibrium in the "natural" liquid, and the stable or "natural" melting-point corresponding to the point of intersection of the (T, x)-equilibrium curve of the liquid with one of the saturation-curves of the pseudo-binary system. Researches on the tautomeric equilibria of enol-keto systems have greatly extended these results. Prof. Smits's theory amounts to extending Bancroft's views to the solid crystalline as well as to the liquid state.

During the last fourteen years Prof. Smits has gradually elaborated his theory on the basis of the thermodynamic treatment of homogeneous and heterogeneous equilibria, and he and his collaborators have published a very large number of exceedingly interesting researches bearing on the question. One might refer particularly to the very thorough investigation of the phosphorus system. He has also extended his theory in recent years to the electrochemical equilibria existing between atoms, ions, and electrons in both solids and solutions, and has obtained new formulæ for the potential differences existing between metals and solutions, etc., and new explanations of such phenomena as polarisation (cathodic and anodic), over-voltage, passivation and activation, etc.

In the present volume Prof. Smits has given a full account of his theory, of the tests to which he has subjected it, and of its application to many phenomena observed or examined by himself and others.

In recent years a difficulty has arisen with regard to the newer views of crystal structure obtained by X-ray methods, which may be put briefly thus: If the older view of a crystal as a molecular structure is to be replaced by one where the structural units are atoms, how can we regard a crystalline phase as a solid solution of two different molecular species in inner equilibrium? Prof. Smits deals with this difficulty in a special chapter of his book. He points out that the differences which characterise his molecular species may be often of a rather fine or subtle type, and that these differences may very well persist in a crystal structure in spite of the close juxtaposition and intimate inter-relationship of the atoms of different molecules. The present reviewer would suggest that possibly it may be a question of the number and distribution of energy quanta in and amongst the various atoms and atomic groupings. In other words, we may have to do with a kinetic equilibrium of energy-contents rather than with molecular species differentiated by structure in the ordinary sense of this term.

Prof. Smits is clearly a man who is not afraid of daring generalisations. He has developed his theory fully from the graphical thermodynamic side, and applied it to the explanation of a large number of phenomena not otherwise easily explicable. Some critics may think he has pushed his theoretical views too far, but undoubtedly his theory has cast a flood of light on many obscure phenomena. It has led, and is constantly leading, himself and his collaborators to numerous quantitative experimental researches, and what more can one ask of any theory? And how many true Baconians are there who can experiment well without a theory to stimulate interest?

For the present well-written and clear account of his work all chemists owe Prof. Smits a great debt of thanks. F. G. DONNAN.

The Birds of Australia.

A Manual of the Birds of Australia. By G. M. Mathews and T. Iredale. Vol. 1: *Orders Casuarii to Columbae.* Pp. xxiv + 279 + plates. (London: H. F. and G. Witherby, 1921.) 3 guineas net.

AUSTRALIA, the birds of which have a foremost place among those of the world for their variety of form and beauty of plumage, has been fortunate in having two splendid treatises devoted to its avifauna, namely, John Gould's magnificent volumes, published between the years 1840–48, which are pictorially unrivalled among ornithological works; and the recent valuable and beautiful work by Mr. Mathews. Apart from these great and costly books, there has long been a want of a modern handbook on the subject at a moderate price, not only by those who are specially concerned with the Australian ornis, but also by students interested in bird-life generally. Gould realised this, and in 1865 published his excellent and useful "Handbook of the Birds of Australia" in two octavo volumes. From 1865 to the present time our knowledge relating to the birds of Australia, as of all other countries, has advanced prodigiously, and the old handbook is now quite out of date. Very fortunately, however, Mr. Mathews, like his eminent predecessor, has realised that an up-to-

date work, within the reach of most, was greatly needed, and with Mr. Iredale has undertaken to supply the desideratum—hence this first volume of the four which are to complete the work.

In the neat and handy volume under notice the authors deal with 188 species and their numerous racial forms, comprised in the orders Casuarii, Sphenisci, Procellariæ, Fregati, Pelecani, Lari (including the Limicolæ), Ralli (including the Colymbidæ and Podicipidæ), Galli, and Columbæ. These orders and their component sub-orders, families, and genera, together with their diagnostic characters, are fully described. Under species the necessary synonymy, plumages from nestling to adult, nests and eggs, distribution and sub-species —including the range and diagnostic definitions of nearly 700 racial forms—are given. As a further help to identification, a series of illustrations is furnished in the form of ten coloured plates depicting more especially hitherto unfigured species, immature birds, and nestlings in down; while thirty-six plates in monochrome contain some 300 figures devoted to the elucidation of the characters upon which the various species treated of in the volume are based. These plates and drawings have been prepared by Lilian Medland and are excellent, but in some of the coloured plates the reproductions, though good and very useful, have not done full justice to the artistic merits of the originals.

We may not always be in sympathy with the views of the authors on the vexed question of nomenclature, and on the recognition of racial forms which are sometimes based upon too trivial characters; nor are we aware that the curlew sandpiper breeds in "Arctic Europe." These, however, are small matters, and it is a pleasure to recommend the book as one which, being the product of consummate personal knowledge, admirably fulfils its purpose, is excellent in all respects, and will doubtless be much appreciated by ornithologists. W. E. C.

Climatic Factors in Agriculture.

Agricultural Meteorology: The Effect of Weather on Crops. By J. Warren Smith. (The Rural Text-book Series.) Pp. xxiv+304+8 plates. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1920.) 13*s.* net.

IT has been said—and the statement is very generally true—that in most soils the crop yield is more affected by the weather than by manuring and cultivation. For this reason it is necessary to repeat most field trials for a number of years in order that the variations due to climate may be averaged out; and if at the same time meteorological records are taken it is possible to trace out some of the relations between weather fluctuations and the variations in yield. The infinite variety in meteorological conditions and in the factors concerned in plant growth makes statistical examination of the results essential if trustworthy information is to be obtained. The great value of long-continued experiments in this connection is clearly pointed out in the book under notice, and a large number of exceedingly interesting correlations are given between the yields of various crops and the weather characteristics—rainfall and temperature—not only over the whole year, but also over limited portions of the growing season. As more data become available it will be possible to specify the most critical periods of plant growth, and the economic value of forecasts of crop yields will be considerably increased.

The effect of climate is not confined to the final yield of the plant; it operates throughout its whole life, not only directly, but also indirectly through the soil conditions, insect and other pests, and so on. The relations must be considered, therefore, from many aspects—ecological, physical, physiological, to mention only a few. The difficulty of presenting such diverse material in a continuous and logical manner is obvious, and the author is to be congratulated on the success he has achieved.

Most readers of the work will be greatly interested in the methods adopted by the U.S. Weather Bureau in preparing and issuing weather forecasts and warnings. Full advantage is taken of these warnings, not only by the growers of specialised crops, who employ various forms of heaters to prevent damage from frost, but also by the general farmer, especially in the important harvesting periods.

In one or two minor aspects the book might be improved. The explanation of the method of working out correlation coefficients could be shortened; the student should be expected to know the way to solve simultaneous equations. Further, the section on physiological indices should adequately include the work of F. F. Blackman and V. H. Blackman, and a discussion of the views of Matisse would not be out of place.

The suggested laboratory exercises at the end of each chapter are excellent. They are intended primarily for university students, but many of them contain stimulating suggestions which could profitably be followed up by experienced research workers.

Agricultural meteorology must inevitably attract more workers in the future. It is to be hoped that the literature of the subject will maintain the high standard set up in this book.

B. A. Keen.

Our Bookshelf.

Hiroshige. By Yone Noguchi. Pp. ix+38+19 plates. (New York: Orientalia; London: Elkin Mathews, 1921.) 25*s.* net.

WE thank Mr. Elkin Mathews for sending us this charming volume. We have admired once more the delicate art of Hiroshige, and we have read Mr. Noguchi's criticism with interest (Mr. Noguchi is always interesting); but we are left wondering why a work of such purely artistic content was submitted for review in a scientific journal. And, as we muse, the question takes form. Is there, after all, so great a difference between the artistic and the scientific approach to Nature? The multitudinous facts and ideas that make up the manifold variety of the world must flood and overwhelm any mind that attempts to grasp the whole. Most of us are saved from seeing too much, if not by native blindness, then by the blinkers of custom and education; but the penetrating eye of the artist or the philosopher looks for safety to the guidance of selection. He is, to quote Mr. Noguchi, "like Hiroshige himself who paid no attention to the small inessential details, when he grasped firmly the most important point of Nature which he had wished before to see, hold and draw." Perhaps the man of science may learn from the great artist, Hiroshige or another, that the searcher after Nature's secrets must frame a clear idea of what he wants to know; that he must not be led astray by facts, useful enough in their time and place, but irrelevant to his quest; that he must make himself the master and not the slave of his facts, so as, without falsifying Nature, to transcend her. It is the fearless vision, the intelligent choice, and the controlling imagination that produce alike the inspiring picture, the supreme poem, and the conquering theory of science.

Do you not agree? Well then, let us simply yield to the fascination of Hiroshige's balanced colour and of Mr. Noguchi's curiously expressive prose.

The Way of a Trout with a Fly, and some Further Studies in Minor Tactics. By G. E. M. Skues. Pp. xvi+259. (London: A. and C. Black, Ltd., 1921.) 18*s.* net.

THOSE who fish for trout with a fly will find that this book raises most of those problems which anglers debate so earnestly, if sleepily, after a day by the river. Mr. Skues claims no finality in his solutions, but that is not the only or the chief objective. His work is in the true line of descent from Izaak Walton and the Dame—that of one who loves and observes most patiently the secret processes of fish-life in our chalk-streams.

Some pages are devoted to the advocacy of what, on a "dry fly" water, is usually regarded as heresy. When a trout is feeding under the surface Mr. Skues will suit his taste with a sunk fly. Omar Khayyám held drunkenness and sobriety in equal abhorrence. Mr. Skues scorns the insobriety of the mere "lure" angler, who will play on any fishy weakness, as much as the asceticism of the "dry-fly purist." If your trout be only feeding on larvæ or nymphs, then have at him under water with a "legitimate" imitation and our author's blessing. And if Viscount Grey or the shade of F. M. Halford shake a deprecating finger, Mr. Skues merely taps his basket, full of fat two-pounders.

The Study of Geological Maps. By Dr. Gertrude L. Elles. (Cambridge Geological Series.) Pp. viii+74+7 plates. (Cambridge: At the University Press, 1921.) 12*s.* net.

DR. ELLES has lectured for several years past on this subject to women students at the University of Cambridge, and the well-printed and fully illustrated book under notice is based upon the course of instruction that she adopted. The relations of outcrop to contour-lines are shown in a series of boldly drawn maps, each with a section of the selected bed below. The details in these are intended to lead students to construct similar exercises on their own account. The shaded drawings of outcrops in relation to topography are excellent. British examples are used as types, and include the cauldron-subsidence of Glen Coe and the reversed fault in the Clifton gorge. Evidently the travels of the author throughout our islands have been aptly utilised. Some account might have been added of the methods adopted by the Geological Surveys of various countries for recording geological features on maps, especially in regard to the differentiation of superficial (surficial) deposits, since the range and variety of geological maps of our own islands are still unknown to many workers. G. A. J. C.

The Land and its Problems. By Christopher Turnor. (A New Series on Economics.) Pp. 254. (London: Methuen and Co., Ltd., 1921.) 7*s.* 6*d.* net.

MR. TURNOR is well-known as an enthusiast in agricultural matters, and in this small book he sets out his ideas in a clear and moderate manner. His purpose is to lay stress on the vast importance of the land as the greatest imperial and national asset, and to show that if a permanent consolidation of the Empire is to be achieved this can be effected only by giving the necessary care and thought to the development of our land resources.

The author is a great believer in small holdings. He does not, however, suggest that the United Kingdom should be devoted entirely to this purpose, but he emphasises the national and social importance of maintaining a number of these holdings—*i.e.* farms of about 50 acres and under—and on the need of improving living and business conditions of the small-holders. He further insists on the necessity for increasing the area of ploughed land. The book is illustrated by charts showing the changes in British agriculture during recent years.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Metallic Coloration of Chrysalids.

THE chrysalids of many butterflies have the appearance of being gilded. The area covered by the gilding is variable even in the produce of the same batch of eggs, in some cases showing only round the prominences on the back, and in others diffused over the greater part of the surface.

Modern naturalists seem inclined to explain animal coloration as being either protective, warning, mimetic, or the result of sexual selection, but the ornamental gilding above referred to can scarcely fall into any of these classes. Protective resemblance, *i.e.* the similarity between an animal and its usual surroundings, is met with everywhere, and natural selection would, or might, act continuously, to promote this resemblance. The opportunities, however, for selection to cause members of different genera to assume the same appearance would be much fewer.

I do not know of any evidence which would point to the models as being of older types than the supposed copyists, but even if such evidence existed, the probability that the similarities are due to selection is of a different, and lower, order than that which connects selection and congruity of colouring with environment.

Considering that, apart from the latter tendency, nothing whatever is known as to the origin of the various types of markings and colour patterns, it would seem justifiable to put down many cases, at least, of what is called mimicry to the action of the same unknown cause.

Chrysalids are often protectively coloured (amongst the Pieridæ, for instance, if the pupa is placed on a wall or paling it is greyish with dark specks, but if on a leaf the colour is a uniform green); there are very few positions, however, in which a bright metallic object would not be more conspicuous than a duller surface similar in tint to its background.

The nature of the metallic colours, of which there are such abundant instances in the animal world, has always been a matter of interest, and during the last twenty years I have examined many hundreds of examples of the kind, and have found in every case that the metallic appearance was due to some form of "interference."

Colour, in general, is the result of a selective action of matter on the light which reaches it, and may arise either from a relation between the wave period of the light and the molecular periods of the matter, or from a relation between the wave-lengths of the light and some structural dimension in the substance built up of numbers of molecules.

The first of these alternatives includes all pigmentary colours, while the action of the second is properly described as "interference."

Pigmentary colours are analogous to the phenomena of resonance in sound, and interference effects to those of combined echoes.

The interference colours of birds and insects take so many forms that it is not always easy, at first sight, to distinguish them from pigments, but a decisive test may be found by subjecting the coloured material to pressure.

If the application of pressure causes the colour to disappear, interference may be safely inferred. If the colour changes, but does not vanish, interference is probable, but not certain.

Fig. 1 shows the apparatus which I made for carrying out this test. It consists of a quartz plate A and a plano-convex quartz lens B, which can be pressed into contact or withdrawn from A by the adjusting screw C. Other adjustments are provided for traversing A in its own plane and for clamping the apparatus in its correct position on the stage of the microscope.

In use, B is first brought into contact with A, and the series of Newton's rings thus formed is centred in the field of view. B is then withdrawn and a small piece of the material to be tested is placed on A, and A is moved by its own adjustment screws so as to bring the test-piece into the same position as was occupied by the centre of the ring system.

Various other tests, such as immersion in various fluids, may be applied to determine the character of the interference, and some of these are mentioned in the paper on "Iridescent Colours" (Proc. Roy. Soc., A, vol. 85, pp. 598 *et seq.*).

In the majority of the cases which I have examined the colours seem to be analogous to those of Lipmann

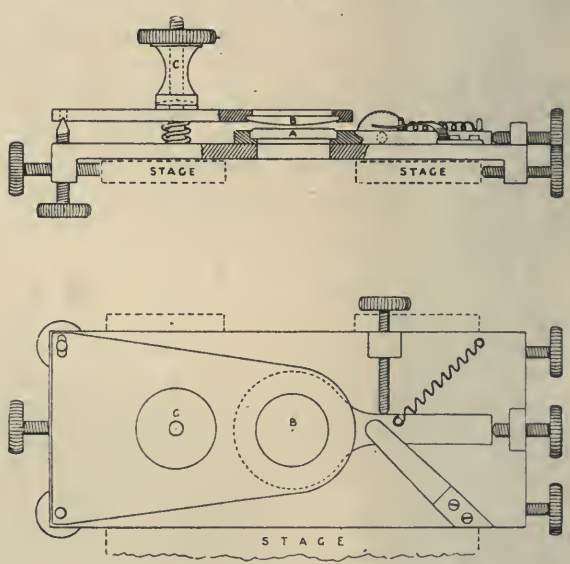

FIG. 1.—Section and plan of apparatus for applying pressure to coloured test-pieces.

films, but it is almost impossible to cut sections thin enough to show this by direct evidence. It may be stated, however, that in the case of birds and insects they are not due to diffraction (an explanation which has often been put forward in books on natural history). I have not yet examined the iridescent colours of fishes and reptiles. From their appearance I should expect that of the former to be interference phenomena, but that the splendid iridescence shown by the scales of some pythons may be the result of diffraction.

It is true that the scales of many Lepidoptera are traversed by fine and regularly spaced lines, and I have used a single scale from a Morpho as a diffraction grating, but the diffraction spectra have no relation to the colour which is directly reflected.

To return to the gold of the chrysalids, I find (1) that the gilding disappears completely when pressure is applied; (2) no immediate change occurs on immersion in water, alcohol, or xylol, but in the course of a few days the gold tends to become more orange; (3) the metallic appearance vanishes when

the specimens are dry, and this happens also (probably for the same reason) about a day before the imago escapes; (4) when the chrysalis is examined with a low power, the gold is seen to be made up of small patches of colour ranging from red to green, with yellow predominating; and (5) all these colours shift towards the blue as the angle of incidence increases.

An enlarged sketch from a photograph of a thin section of the wall of the chrysalis is shown in Fig. 2. Photographs of subjects such as these are generally unsatisfactory owing to the impossibility of getting all the significant features in focus at the same time.

The section shows an inner membrane (*a*), which stains readily, and is traversed by closely spaced fine lines (about 30,000 per in.), covered by a thin chitinous coat (*b*) having many corrugations on the outer side.

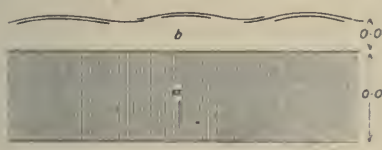

FIG. 2.—Section of a portion of a chrysalis of *V. urticae*. (From a photograph.)

Of the foregoing observations, which were made on a series of chrysalids of *V. urticae*, (1) proves the colour to be the result of interference, and (5) is in agreement with this; (2) shows that the interference is not a surface effect, but is due to some internal structure in the chitin; and (2) and (3) together indicate that the periodic structure changes its properties and dimensions by wetting and drying.

In some very thin sections I have thought I could recognise separate layers at the borders of the chitinous coat, but it is difficult to distinguish with certainty this apparent stratification from the diffraction bands which are often seen at the boundary between two substances of different refractive index.

A. MALLOCK.

9 Baring Crescent, Exeter.

Sex-manifestations and Motion in Molluscs.

IN NATURE of October 13, p. 212, Mr. G. C. Robson discusses the application to molluscs of the present writer's suggestion that bisexuality in animals may be a direct physical result of a freely moving habit of life, and that hermaphroditism may be a direct physical result of a sedentary or sluggish mode of life. It was also suggested that it follows from this hypothesis that all sedentary or sluggish animals may be suspected of hermaphroditism where they are now supposed to be bisexual, especially in view of the fact that sex-change may be obscured by a rapid change-over of sex-characters such as we know takes place in the oyster.

Mr. Robson's discussion brings out some of the difficulties experienced in applying the generalisation to molluscs, but at the same time illustrates some facts in its favour. It is suggested that the marine Euthyneura, which are hermaphrodite, are as "active" as the Streptoneura, which, except for some sedentary and parasitic forms, are bisexual. This difficulty is a real one if a comparison be made merely of the behaviour of the animals in captivity; but if "activity" be defined in relation to muscular development, it will at once be seen that there is a great difference between the Streptoneura and the marine Euthyneura. An Aplysia, or even a Scaphander, as a type of marine Euthyneura is a flabby and feeble animal in comparison with the strong, powerful, muscular Buccinum as an equivalent type of Streptoneura. Indeed, the difference in muscularity between the two groups might very well be regarded as of fundamental importance by a biophysicist.

It is considered undesirable to attempt to define closely such terms as "sluggish" and "active," since if there is any underlying truth in the hypothesis proposed, definitions would soon begin to crystallise out when the problem begins to be seriously attacked. The degree of muscular development will, however, probably enter largely into the definition of "activity" from this point of view. In this respect the following quotation—warm from the press—("Mechanism of Life," by J. Johnstone, 1921, p. 218) is of great interest:—"The animal[1] is characteristically a machine for the conversion of potential chemical energy into movement of body and limbs, and the movement inevitably leads to friction." As an illustration of another apparent contradiction of the hypothesis, the Ctenophora may be mentioned. These forms (excepting the Berœ group) are "active"—that is, they move about quickly; but there are also at least many of them hermaphrodite. The Ctenophores (except the Berœ group), however, move about, not by means of muscular movements, but by the rhythmic action of compound flagella, and this, it is submitted, may be regarded from a biophysical point of view as a mode of locomotion fundamentally different from that brought about by muscular action.

The illustration from Mr. Robson's letter in favour of the hypothesis relates to the fact that among the Streptoneura, which are typically bisexual, are a few sedentary and parasitic forms. Now these parasitic forms are hermaphrodite, and so also are those sedentary forms, namely, Crepidula and Calyptræa, which have been critically examined. Moreover, it may be observed that such simple cases of hermaphroditism as occur in Crepidula and Calyptræa have been described only recently, and that, therefore, more difficult cases may very easily have been overlooked; further, it is not at all incompatible with possible hermaphroditism in a species for a hundred specimens of that species (not to mention a mixture of several species) to be examined unsuccessfully for products of both sexes; even in the oyster Hoek ("Rapport over de oorzaken van den achteruitgang in Hoedanigheid van de Zeeuwsche oester," p. 174, Uitgegeven door het Ministerie van Waterstaat Handel en Nijverheid, s' Gravenhage, 1902) found only 11 hermaphrodite forms out of 130 examined microscopically, and we now know that sex-change occurs seasonally in this species. In other species—where sex-change may occur only once in a lifetime—it would be easy to predict a case where less than 1 per cent. of a random sample would be hermaphrodite, especially as both sex-products may not be produced simultaneously.

It is not a difficult matter to raise objections to the general hypothesis in relation to doubtfully active animals; therefore, results of practical applications of the suggestion are more interesting. For instance, are all the sedentary Streptoneura, the Scaphopoda, and the Polyplacophora really hermaphrodite, although they appear to be bisexual? It must be remembered that Nature can attain the same end in all kinds of ingenious ways, as though delighting in obscuring the application of any underlying principles, if such do, indeed, really exist. For example, the present writer applied the hypothesis stated above to an inves-

[1] Prof. Johnstone is of course referring to the metabolism of undoubtedly active animals.

tigation of the sex-phenomena in the pea-crab, the female of which is known to be sedentary, spending its life imprisoned within bivalves such as mussels, cockles, and occasionally oysters. It was found that the female fulfils its mating functions probably once and for all (see NATURE, December 23, 1920, p. 533) when quite a tiny mite, and probably not more than a month or two old. It is unlikely afterwards that the female has any more need of a male. Now the same result—excepting for any advantage there may be in cross-fertilisation—might be obtained by the pea-crab being born as a male and changing into a female, and at the outset of the investigation such a change was suspected. It is, indeed, possible, that evolution in sex-characters in a similar species carried a stage further would end in cutting out the males of that species altogether—as has taken place in some Cirripedes—and leaving a hermaphrodite form which starts life as a male and changes into a female. In the case of the pea-crab, therefore, bisexuality is maintained by a very precocious association of the sexes, while the males still retain their active mode of life.

A similar dodge on the part of Nature has been applied in a large number of other cases, such as in some parasitic Copepods, some Echiuroids, some Cirripedes, some parasitic Isopods, and no doubt in many other cases. But in these cases the male is often minute and permanently attached to the female. It is clear, therefore, that it is necessary to be on the look-out for adaptations which retain in a species an appearance of bisexuality, but which bring about a close resemblance to the hermaphrodite state. The conditions which determine whether both sexual products shall ripen together in an individual or only successively are entirely unknown, but it is hoped that the suggestions put forward in this letter may help towards securing some information bearing on the problem.

J. H. ORTON.

The Laboratory, The Hoe, Plymouth,
October 20.

The Presence of Perennial Mycelium in Peronospora Schleideni, Unger.

SINCE *Peronospora Schleideni*, Unger, the onion mildew fungus, is known to produce its sexual organs in the leaves of the host-plant, the assumption has been made that the parasite is dependent on its oospores for perpetuation from year to year. It has now been proved, however, that the mycelium is capable of a perennial existence in onion bulbs, and that the shoots produced if such bulbs are planted are infected *ab initio*.

The presence of non-septate mycelium permeating the bulbs of the potato- and common onion, sent in from several parts of Ireland in the late spring of 1920, first directed attention to the subject. All attempts to induce this fungus to fruit on the bulb-scales, to infect other onions, or to grow on artificial media, met with failure. In some cases, however, where green leaves were present, the mycelium was traced from the bulb to the apical portion of a leaf on which conidiophores of *P. Schleideni* were being produced. All the infected bulbs shrivelled and died during the course of the autumn or winter, as did further infected specimens gathered in the autumn from badly diseased plots. Practically 66 per cent. of the smaller-sized onions from one particular plot which was badly mildewed in 1920 contained non-septate mycelium. Such infected bulbs sprouted prematurely, but although the mycelium grew up within some of the new shoots, it failed to develop conidiophores on the surface under winter conditions in the greenhouse.

Further material became available in the spring which proved the relationship of this fungus to *P. Schleideni*. Bulbs of the common onion (*Allium Cepa*) and of the shallot (*A. ascalonicum*) which contained the same non-septate mycelium were grown in the early spring under conditions which excluded the possibility of external infection, as proved by the fact that numerous control plants which were initially free from mycelium remained free from mildew, even when kept for a week under conditions favourable to the disease. The infected plants, on the other hand, when placed under a bell-jar for one night were found practically covered with mildew next day. In some cases the original infected leaves, which had not developed any mildew, were cut away. The new shoots which replaced them again came up permeated with mycelium and again became mildewed under favourable conditions, while similarly treated control plants remained healthy.

There is a time in the early spring, generally in the month of April, when the mildew is found only on onions the bulbs and leaves of which are permeated with mycelium. These plants appear to act as important centres of infection. For a long period no apparent harm results to the host, but the tips of the leaves ultimately turn yellow and droop. Under favourable weather conditions mildew then breaks out, at first just below the withered portion of the older leaves, and then on all the leaves except the youngest. There appears to be a nice balance between host and parasite, seeing that both can go on flourishing so long together, and that it is apparently only at a certain stage of maturity of the leaves that the internal mycelium breaks out into conidiophores. Even when this happens, the host-tissue is not killed for a considerable time.

Non-septate mycelium, apparently that of *P. Schleideni*, has been found in the bulbs of the common onion, in those of the potato- or underground-onion, and of the shallot. In the case of the common onion and shallot this mycelium has been definitely connected with the mildew fungus. It has also been proved that the mycelium survives when infected bulbs are left in the soil during the winter. This is possibly an important point in the case of Tripoli onions, which are sown in the autumn. The *rôle* of perennial mycelium in the shallot, potato-onion, and in onions grown from "sets" is obvious.

Plainly visible mycelium was observed in infected bulbs every time they were examined in spring, autumn, and winter. In these circumstances, it appears unnecessary to suggest the presence of mycoplasmic infection. It may be added that the mycelium is so obvious, the hyphæ being stout and well differentiated from the cells of the host-plant, into some of which large convoluted haustoria extend, that no better subject for demonstrating intercellular mycelium and haustoria is known to the present writer. No staining is required.

The effect of the fungus on the keeping qualities of infected bulbs requires further study, as do some other points in this strangely overlooked phase in the life-history of such a common and destructive parasite.

PAUL A. MURPHY.

Royal College of Science, Upper Merrion
Street, Dublin, October 15.

The Development of Optical Industries.

IN NATURE of October 20, p. 238, Messrs. Zeiss's publicity manager questions a particular period of British supremacy in the manufacture of optical glass,

and in doing so he minifies the value of Faraday and Harcourt's work. Of Harcourt he says: "The result at that time (between 1834 and 1844) was scarcely of any practical importance."

Now what does Dr. Zschimmer, who until the Revolution was chemist to Messrs. Schott, of Jena, say? I shall translate from his book, "Die Glasindustrie in Jena" (p. 22), and throughout I shall limit myself to quotations from German sources: "With Harcourt's experiments there began in the year 1834 the systematic 'scientific melting' of glass in the laboratory. He was the discoverer of the first research furnace for fusion at high temperatures, the first who was able to complete numerous small experimental melts, and thence to determine by spectrometer measurement the optical properties—refraction and dispersion—of various extreme glass substances."

On p. 23 he continues: "Harcourt . . . discovered the power of molten phosphoric acid and boric acid to form glass with almost all the elements, and on account of their fluidity he substituted them for the more viscous silica. Already in 1844 he was able to communicate to the British Association the happy success of his first experimental melts, the further object of which was to compare the chemical constitution with the optical properties of different glasses. . . ."

Dr. Zschimmer is generous, but not unduly so. A genuine man of science himself, he has recognised the great, far-reaching practical results of Harcourt's work, but Dr. Zschimmer has embarrassed us. In accepting his opinion we must doubt that of Messrs. Zeiss's representative, whose declared object it is to "furnish some trustworthy historical data."

Messrs. Zeiss's spokesman questions to-day the statement in NATURE that: "If the British optical industry is to be maintained and to develop so as to turn out products equal at least to the best products of other nations, it must not be dependent on foreign sources for the supply of optical glass, but must have an adequate home supply, equal, again, at least to the best available anywhere." "History," he says, "does not point to the existence of such a very close relation between the welfare of the glass-founder and of the optical instrument-maker in the same country."

Does it not? Is Messrs. Zeiss's publicity manager so unfamiliar with the history or the Jena establishments? If in the above statement from NATURE the word "German" be substituted for "British," we have the essence of the original appeals for a subsidy made to the Prussian Government. In this connection I shall translate part of a vigorous statement made by Rudolf Virchow: "It concerns itself, indeed, with a national undertaking, the object of which is to produce in Germany in an independent way the glass necessary for all scientific purposes, and also to provide for the population what is necessary for the production of spectacle glasses, opera glasses, and the like. Nevertheless the latter is not the principal object. It concerns itself, moreover, to the highest degree with the production of glass for telescopes, microscopes, and such like scientific instruments. This question is of very special importance as regards the construction of instruments for military and naval purposes, in which connection we have hitherto been entirely dependent upon foreign countries. In the previous year it was proven to the Budget Commission that only by a particular accident was it possible to obtain the necessary quantity of glass for the construction of optical instruments essential for the army."

"The close relationship between the welfare of the glass-founder and of the optical instrument-maker in the same country," thus forcibly advocated, was already recognised by the Prussian Government, which "granted to the Jena undertaking for two years a sum of 60,000 marks."

JAMES WEIR FRENCH.

Anniesland, Glasgow, October 24.

THE letter published in NATURE of October 20 from the Carl Zeiss organisation in Jena through Messrs. J. W. Atha and Co. is interesting, but not very convincing, for Messrs. Zeiss seem to wish to convey a totally different impression from that of thirty-five years ago. Their present attitude is that although they did receive a small subsidy, a mere 3000*l.*, from the Prussian Government, it was an isolated instance and really quite unnecessary. In view of this the following extract from the preface to the catalogue of optical glasses issued by Schott and Gen in 1886 is interesting:—"We have to express our sincere thanks to the Prussian Bureau of Education and to the Diet of the kingdom for the *very liberal and repeated subsidies* by which we were enabled to carry out the costly experiments on a manufacturing scale." The italics in the quotation are mine.

An analysis of the various optical glasses offered in this 1886 catalogue gives food for thought. Forty-four glasses were offered, of which it was claimed that nineteen were essentially new, and so were printed in heavier type. Fourteen of these were entirely withdrawn from the market within a year or two, as they were absolutely unstable, and were never replaced. Of the remaining glasses five had the following significant remark printed against them, presumably as a recommendation: "Exactly corresponds to the hard crown (soft crown, dense flint, etc.) of Chance Bros." Of the remaining glasses it may be said that they were merely slight modifications of the ordinary old-fashioned crowns and flints, having slightly lower or higher refractive indices than ordinary hard crown, light flint, or dense flint, and a correspondingly lower or higher dispersion, many of which had been produced by Chance years before.

MANSELL P. SWIFT.

81 Tottenham Court Road, London, W.1,
October 25.

IN their letter to NATURE of October 20 (p. 238), Messrs. Zeiss suggest, by implication, that British optical instruments are inferior to those of German manufacture. The following may be of interest:

I possess three photographic lenses. One a pre-war Goerz; double-anastigmat, 7-in. focal length, working at f/6·8, and two post-war Cooke lenses, one of 8¼-in. focal length, working at f/4·5, and the other of 15-in. focal length, working at f/5·8.

All three lenses have recently been tested at the National Physical Laboratory. The full reports are too lengthy for publication, but it suffices to quote that the Goerz lens had to be stopped down to f/16 to give "satisfactory definition over the entire plate," whereas the Cooke lenses did this at *full aperture*.

The Goerz lens, I was informed, was specially selected for me by Messrs. Goerz's agency in London, whereas both Cooke lenses were bought from stock at the Army and Navy Stores.

Possibly one important factor in the success of the German optical industry is the skilled way in which their products are advertised. The delusion that they are unequalled is widespread.

K. C. BROWNING.

16 Bridge Avenue Mansions,
Hammersmith, W.6.

Qualities of Valency.

In a letter under the above heading in NATURE for October 13, p. 210, Dr. R. M. Caven directs attention to the difficulty felt by chemists in accepting Dr. Langmuir's view that the sodium and chlorine in sodium chloride are not united by a chemical bond, being always ionised, although molecules of sodium chloride actually exist in a state of vapour at 2000° C. Perhaps the following considerations may help to remove the difficulty.

In the first place it is necessary to distinguish between the two separate processes of intramolecular ionisation and electrolytic dissociation. Intramolecular ionisation is the expression introduced by Sir J. J. Thomson to describe the transfer of an electron from one atom to another *within* the molecule, an "ionic molecule" being thereby produced. Electrolytic dissociation is the breaking up of such an ionic molecule into separate ions.

Sodium chloride is therefore an intramolecularly ionised compound, and the chemist's difficulty is the question of how the ions are united in the molecule.

Now the conception of the valency bond can be retained if we accept the convention first suggested by Sir Oliver Lodge (NATURE, vol. 70, p. 176, 1904), according to which the electron and positive charge are united by a very large number of lines of force when in combination. In the chloride ion we have a kernel with seven positive charges surrounded by eight electrons. The electrons will, therefore, be unsaturated, and in a molecule of sodium chloride we shall have a bundle of lines of force passing from the electrons of the chloride ion to the nucleus of the sodium ion. This is a typical instance of a strong electrolyte.

In non-electrolytes two or more electrons are shared between two atoms, giving Dr. Langmuir's covalency bond. In this case, without specifying the particular electrons involved, we may assume a double bond consisting of two equal bundles of lines of force passing in opposite directions, that is to say, in a molecule AB, one bundle will pass from the electrons of A to the nucleus of B, and the other one from the electrons of B to the nucleus of A. All intermediate stages of combination between these two extremes are possible, as I have pointed out in a series of papers, in which the subject is discussed in detail (Trans. Chem. Soc., vol. 111, p. 253, 1917; vol. 115, p. 278, 1919; *Phil. Mag.*, vol. 42, p. 448, 1921).

Full consideration of the question, as shown in the papers referred to, leads to the conclusion that a simple and all-embracing theory of valency is not possible, but that different theories of valency must be devised for different types of compounds, such as electrolytes, non-electrolytes, and molecular compounds. In view of this difficulty I have used affinity formulæ only, and it would appear that the time is approaching when the chemist will have to decide whether the conception of valency can be retained for general purposes, or whether it would not be better to restrict its use to certain special branches of the science, such as the chemistry of carbon compounds, in which it has proved of supreme value.

To the inorganic chemist the valency conception has been of doubtful value. This is particularly noticeable if we compare the rapid development of inorganic chemistry since Werner introduced the co-ordination theory less than thirty years ago with the slow rate of progress in the previous thirty years under the valency theory.

In any case the restricted use of the valency bond to the particular type of combination termed covalency by Dr. Langmuir will scarcely be accepted by chemists if the conception of valency is to be retained for general purposes.

The other facts mentioned by Dr. Caven all indicate that there is no clear-cut distinction between electrovalency and covalency, but that they represent extreme types of combination with an indefinite number of intermediate grades. S. H. C. BRIGGS.

October 24.

Relation of the Hydrogen-ion Concentration of the Soil to Plant Distribution.

With reference to Dr. W. R. G. Atkins's interesting communication in NATURE of September 15, may I be allowed to submit the following comments? The importance of the study of hydrogen-ion concentration in physiology and biochemistry, soil science, and other branches of research cannot be over-emphasised, and is rapidly becoming appreciated by workers. There appears, however, to be a tendency to apply methods of measurement that have been standardised in one branch of study to other departments—soils, for example—with a minimum change of technique. With the exception of Gillespie's pioneer, but by no means exhaustive, work in America, the colorimetric method of measuring the hydrogen-ion concentration of soils has never been critically examined. After considerable preliminary work with this method—an account of which has been published elsewhere—the present writer feels that the conditions under which it can be applied in soil work so as to yield accurate and reproducible results have not yet been fully worked out. As an example may be cited the fineness of division of the soil sample which is often a factor influencing the apparent pH as determined colorimetrically. Until much more work has been done from this point of view the data being accumulated by ecologists can scarcely have the strict quantitative significance often attached to them, although when regarded as provisional only they are undoubtedly of great interest and no little importance.

A further point is perhaps worthy of attention: it may possibly happen that in some soils the actual pH at the moment of measurement is of less importance than the *rate of change* of the pH under natural conditions. The "buffer effects" imposed by the nature of the soil on its reaction vary enormously in magnitude from soil to soil; a dressing of basic slag may alter considerably the pH of a light sand while having no appreciable effect on that of a heavy loam; and the pH of a light soil may vary regularly or erratically with fluctuations in local conditions. Such variations may be important in many cases, and would well repay study. The whole problem of the nature of soil reaction is complicated, but some light would undoubtedly be thrown upon it by measuring, not merely the pH of soils, but the variations in pH with additions of acids and alkalis, *i.e.* by plotting titration curves the slopes of which can be correlated with the magnitude of the buffer action of the soil. Very little work along these lines has so far been done in this country—or, indeed, in any country—but that little has afforded indications that such work would be fruitful of result if attacked systematically and with due appreciation of all the difficulties.

E. A. FISHER.

The University, Leeds, September 28.

Absorption of X-rays.

At the suggestion of Prof. Richardson, we have for some time been engaged in an investigation of the connection between X-ray absorption coefficients and critical frequencies. In this work we have met with

considerable experimental difficulties, which so far have not been completely overcome. It appears, however, that one of the questions we had set ourselves can be answered, partially at any rate, from some data recently published by Richtmeyer (*Phys. Rev.*, July, 1921, p. 13), who has given the absorption curves of molybdenum and silver for homogeneous X-rays on both sides of their respective critical (κ) absorption frequencies, and for lead on the longer wave-length side. Data on lead have been previously given by Hull and Rice (*Phys. Rev.*, vol. 8, p. 326, 1916), who have also determined one point on the shorter wave-length side. The values of Richtmeyer for lead are proportionately higher than those of Hull and Rice, apparently indicating that the latter have inaccurately determined the thickness of their thin absorbing screen.

By plotting $\log(\tau/\rho)$ against $\log\lambda$, the double values of the mass absorption (fluorescent) coefficients of molybdenum and silver at their respective critical frequencies can be accurately determined. In the case of lead the accuracy of the upper value (for the shorter wave-length side) is governed by the accuracy of the single determination of Hull and Rice as corrected from the Richtmeyer data. The following results are obtained for the ratio of the values $\frac{(\tau/\rho)_{\nu_\kappa+\delta\nu}}{(\tau/\rho)_{\nu_\kappa-\delta\nu}}$ when ν_κ is the κ critical absorption frequency of an element and $\delta\nu$ is infinitely small.

Element	Lead	Silver	Molybdenum
$R=\frac{(\tau/\rho)_{\nu_\kappa+\delta\nu}}{(\tau/\rho)_{\nu_\kappa-\delta\nu}}$	3·5	6·76	7·06
Critical frequency ν_κ	$21·58\times10^{18}$ sec^{-1}	$6·186\times10^{18}$ sec^{-1}	$4·854\times10^{18}$ sec^{-1}

The relation between R and the critical frequency is linear, and is expressed by the equation

$$R=0·212\times10^{-18}(38·1\times10^{18}-\nu_\kappa).$$

The relation between R and the atomic number has been tested, but it does not appear to be nearly as linear as the one given above. The data from which this generalisation has been made are admittedly incomplete, and the experiments are being continued in the hope of testing the extent of its validity.

W. EWART WILLIAMS.
B. L. WORSNOP.

Wheatstone Laboratory, King's College,
Strand, W.C.2, October 15.

The Film-photophone.

IT may be of interest to readers of the Note in NATURE of September 29, p. 161, to learn that the photo-electrical equipment of the "speaking-film" is quite new. It consists of an antimonite cell, and was constructed especially for this purpose by the present writer. A fragment of a single crystal of the mineral antimonite (found in Japan and Borneo) is connected to electrodes (of very large surface) in such a manner that air and humidity are excluded. An even flow of current is thus attained and the sudden, unexpected jerks which formerly destroyed the acoustic effect are avoided.

The photo-electrical properties of antimonite have been known for a comparatively short time. The discovery was made by F. M. Jaeger (of Zaandam) in 1907. The exceptionally high resistance of the first cells was at that time, before the advent of the amplifier, a serious obstacle to technical uses. In 1911 I succeeded in constructing a cell of lower resistance which enabled Prof. B. Glatzel in 1912 to demonstrate graphically by the oscillograph the surprising rapidity with which the antimonite adjusts itself to varying intensities of light.

That synthetic antimonite, made by melting together antimony and sulphur in suitable proportions, is sometimes very sensitive was shown by Olie and Kruyt in 1912.

The investigations of F. C. Brown seem to indicate that single crystals of selenium might also be used with advantage. But they are difficult to make, and the problem of affixing the electrodes is not yet solved. although solutions may be said to be in sight.

W. S. GRIPENBERG.

Helsingfors, Finland, October 13.

THE first two sentences in Dr. Gripenberg's letter are misleading in the sense that they suggest that the only photo-electrical equipment capable of being used with "speaking-films" is the antimonite cell. It is well known, of course, that other substances besides selenium respond to fluctuations of light intensity, and antimonite is, apparently, one of them. Another is the "thalofide cell," which has recently been advertised extensively, and was invented by T. W. Case. I believe I am correct in saying that the sensitive substance in this cell is thallium sulphide. The comparative merits of these various substances will, no doubt, ultimately decide which is best to use with speaking-films. For the present, at any rate, selenium has been by no means completely ousted—a fact which is made evident by its adoption and use in connection with the film-photophone of Mr. Bergland, to the efficient performance of which attention has been directed by the *Times* correspondent.

THE WRITER OF THE NOTE.

Rainfall Records at Rothamsted.

THE following rainfall figures from Rothamsted are worth noting. The records date back to 1852 for the large rain-gauge (1/1000 acre), but for the purpose of comparison the figures for the last fifty years are taken, since the three percolation gauges (also 1/1000 acre) were not built until 1870. They relate to the harvest-year, September 1–August 31 :—

Harvest Year.

	Rain. Inches.	Percolation Through 20-in. soil. Inches.	Through 40-in. soil. Inches.	Through 60-in. soil. Inches.
Average for last 50 years	29·500	14·834	15·482	14·659
September 1. 1920, to August 31, 1921...	16·282	6·921	7·161	6·812

For the past eight months (February 1–September 30) the figures are :—

1921	8·511	1·125	1·230	1·176
Average	18·239	6·525	6·910	6·528

The rainfall for the period September 1, 1920, to August 31, 1921, is the lowest since the records started in 1852, the previous lowest being 19·504 in. in 1897–98. The highest figures for the period are 41·048 in. in 1878–79.

W. D. CHRISTMAS.

Rothamsted Experimental Station,
Harpenden, October 27.

Edinburgh and the Rise of Oceanography.[1]

By PROF. W. A. HERDMAN, C.B.E., F.R.S.

EDINBURGH may be regarded as the birthplace and the early home of modern oceanography, and Edinburgh men and Edinburgh ideas played a leading part during the nineteenth century in establishing this comprehensive science of the sea. Oceanography, if of modern development, is of ancient origin. The foundations upon which it has been recently built can be traced back to very early times, to the records of naturalists and the observations of seamen from the voyages of the Phœnicians onwards, and maps have been constructed to show the growth of our knowledge of the oceans from the shores of the Mediterranean in the time, say, of Homer, and later of Aristotle, on to the Atlantic voyages of the fifteenth and sixteenth centuries, and the circumnavigation of Magellan in 1522, when the first attempt, so far as we know, was made to sound the Pacific with a 200-fathom line at a spot we now know to be about 2000 fathoms deep. Pytheas, who first passed the Pillars of Hercules into the unknown Atlantic, and penetrated to British seas and brought back reports of Ultima Thule and of a sea to the north thick and sluggish, like a jelly-fish, was an early oceanographer in the fourth century B.C.; and so, coming to later times, was that truly scientific navigator, Capt. James Cook, who sailed to the South Pacific on a transit of Venus expedition in 1769, with Sir Joseph Banks as naturalist on board, and later circumnavigated the Southern Ocean about lat. 60° S., and so finally disproved the existence of a great southern continent.

It is impossible in one short lecture to trace all stages and mention all worthy names, but a list of the more notable voyages of exploration in the nineteenth century recalls the names of the great men such as Darwin, Hooker, and Huxley, who went with the ships as naturalists, and all of whom contributed in their turn to our knowledge of the sea and its contents.

Information as to the bottom of the sea and the animals living there is obtained chiefly by dredging and trawling, and we find that the naturalist's dredge, a modification of the fisherman's oyster dredge, came into common use about 1830, and was the chief implement employed by the marine biologists of the nineteenth century, who made known the riches of the British seas.

In tracing the development of the science of the sea, we may take as examples the work of three Edinburgh men, who are types of periods of investigation in the nineteenth century—Edward Forbes, the pioneer of shallow-water dredging during the earlier half of the century; Wyville Thomson, the explorer of the deep sea and scientific leader of the *Challenger* expedition; and John Murray, who continued the work of Wyville Thomson and guided research in the last quarter-century into deeper and more fundamental problems of the ocean, and brought the science practically to its present position and outlook.

Edward Forbes, though of Scottish descent, was born in the Isle of Man about 100 years ago, but much of his short life and his remarkable work was connected with Edinburgh. His long and erratic career as a student of medicine and science was spent here, and he died a professor in the university of the city. As a mere boy in the Isle of Man he commenced his marine biological studies and the accumulation of those collections and observations which afterwards formed the basis of his classic works on "British Starfishes" and "British Mollusca." He left home at the age of seventeen, and from that time onwards the whole of his short, strenuous life was devoted to science and mainly to the science of the sea. He was a many-sided genius, who produced an extraordinary volume of first-rate original work in marine biology and inspired advances in oceanography which he did not live to see carried out.

After a short period of art study in London Forbes arrived in Edinburgh in 1831 as a medical student, and here he remained a student for nine years. It is interesting to note that our three selected leaders in science were all students of medicine in this university, and not one of them graduated. Forbes was the centre of a brilliant group of young medicals, about half a dozen of whom were afterwards fellow professors with him in the same university. The chief of these was perhaps John Goodsir, the famous anatomist, and in 1839 we find Forbes and Goodsir dredging in the Shetland seas, with results which Forbes made known to the meeting of the British Association at Birmingham that summer with such good effect that the celebrated "Dredging Committee" of the association was formed to continue the good work. Forbes and his British Association Dredging Committee may be said truly to have led on, step by step, to the *Challenger* and other expeditions of modern oceanography.

One very curious animal which Forbes and Goodsir made known from Hebridean seas is the bright-green compound Ascidian called *Syntethys hebridica*, which has since been shown to be the same as a Mediterranean animal of a lovely violet colour named by the French naturalist, Savigny, *Diazona violacea*. The animal in our seas is green when alive, but when it dies undergoes a chemical change and becomes violet. As an example of the constancy of Nature, I may add that nearly seventy years after this rare animal had been found by Forbes and Goodsir I went to the Hebridean seas to search for it, and in exactly the same spot, to the north of the Croulin Islands, came upon it in quantity sufficient to supply various museums and give material to my chemical friends who were investigating the pigment.

[1] Abridged from an evening discourse to the British Association at Edinburgh on September 13.

Forbes's great opportunity to make marine investigations outside the British seas came in 1841, when he was appointed naturalist on the surveying ship *Beacon* engaged on hydrographic work in the eastern Mediterranean. His dredgings in the Ægean gave great results and led to the well-known and much-discussed views on zones of life in the sea which are always associated with his name. He defined in the Ægean eight zones of depth, characterised by peculiar assemblages of animals, and he conjectured that the zero of animal life would probably be found somewhere about 300 fathoms—the "azoic" zone—a conclusion which has since been found to be erroneous. His Ægean report was laid before the British Association in 1843, and, we are told, at once raised the author to a high rank amongst living naturalists.

But perhaps Forbes's most important work of an oceanographic nature is the Geological Survey Memoir, in which he traces the origins of the British fauna and flora and their relations to geological changes in the past. He accounted, for example, for the five sub-floras which he defined as due to successive migrations from neighbouring lands previous to the isolation of the British Islands from the mainland of Europe. He showed the northern and southern relations of the fauna of our seas, as exemplified by the fishes and the molluscs, and the presence of "Boreal outliers," assemblages of northern species occupying deeper areas of 80 to 100 fathoms on the west of Scotland. These he regarded as portions of the original northern fauna which formerly occupied our seas and had retreated northwards when the climate became more genial subsequent to the Glacial epoch, leaving these colonies isolated in the deeper holes. Forbes's theories on distribution and on the origin of the British fauna and flora, even if in part erroneous, were a notable contribution to knowledge, and far in advance of anything known at the time, and had an important influence on the history of further investigation. His theories, along with his descriptive work, form a wonderful output both in quantity and quality for a man to have produced who died before reaching the age of forty, only six months after he had attained to the goal of his ambition, the chair of natural history in the University of Edinburgh.

Forbes was the most original, brilliant, and inspiring naturalist of his day, with a broad, philosophic outlook over Nature, and a capacity for investigating border-line problems involving several branches of science—he was, in a word, a pioneer of oceanography and the spiritual ancestor of men like Sir Wyville Thomson and Sir John Murray.

We now pass from this period of the early marine naturalists to that of the later oceanographers of the nineteenth century. If Forbes was the pioneer of shallow-water dredging, Wyville Thomson played a similar part in regard to the exploration of the depths of the ocean. His name will go down through the ages as the leader of the famous *Challenger* expedition, by far the most important scientific deep-sea exploring expedition of all times. Wyville Thomson's work was in direct continuity with that of Forbes. It was Forbes who, on a basis of observations then thought to be sufficient, but now known to have been exceptional, placed the zero of life in the sea at 300 fathoms, and it was Wyville Thomson more than any man who proved that Forbes's views were in this respect erroneous, and that many and varied living things inhabit the greatest depths of the ocean.

Charles Wyville Thomson was born in 1830 at Bonsyde, near Linlithgow, and was in every sense, by ancestry and by education, a son of Edinburgh. Like Edward Forbes, he started as a medical student, but, fortunately for oceanography, after about three years of study, his health gave way, and he left medicine for what was then supposed to be the less strenuous pursuit of science. It is interesting to trace how Thomson's earliest investigations on fossils led on by successive steps to the novel and fruitful field of deep-sea exploration. Palæontological observations on Crinoids suggested work on the living Antedon, and that led to the investigation of the stalked larval stages of that Rosy Feather Star. Then the news that a strange new stalked Crinoid (*Rhizocrinus lofotensis*), related to the fossil Apiocrinidæ, and resembling the larval forms of Antedon, had been found living in northern seas induced him in 1866 to visit Prof. M. Sars at Christiania and examine for himself the remarkable collection of rare animals that the son, G. O. Sars, had brought up from more than 300 fathoms in the Lofoten fiords. Thomson was naturally much struck by their novelty and interest and their resemblance to extinct animals of former geological periods. Thus inspired, he urged his friend, Dr. W. B. Carpenter, with whom he was then working, to join him in endeavouring to promote an expedition to explore the deeper water of the Atlantic. Carpenter's powerful advocacy induced the council of the Royal Society to use their influence with the Hydrographer with such success that the Admiralty placed first one and then another small surveying steamer at the disposal of a scientific committee. Thus came about the cruises of the *Lightning* in 1868 (when they dredged down to 650 fathoms) and the *Porcupine* in 1869 and 1870 (when they reached the great depth of 2435 fathoms) which are described in detail in Wyville Thomson's book, "The Depths of the Sea," the first general text-book of oceanography, published just after the *Challenger* had sailed in 1872. These explorations showed an abundance of life at all depths.

Incidentally we may note that another Edinburgh professor—Fleeming Jenkin, the engineer—when repairing a cable in the Mediterranean in 1860 brought up some sessile animals attached to the broken cable from more than 1000 fathoms.

Wyville Thomson succeeded Allman as professor of natural history in Edinburgh in 1870, and from that time Edinburgh became the active centre of deep-sea exploration. The undoubted success of the preliminary expeditions in the *Lightning* and *Porcupine* encouraged Carpenter and Thomson, again through the council of the Royal Society, in co-operation with a committee of the Council of the British Association, to induce the Government to equip a deep-sea expedition on a really grand scale to explore the conditions of life in the great oceans. This resulted in the famous circumnavigating expedition of the *Challenger*, with Sir Wyville Thomson as director of the scientific staff. On that staff were also two other Edinburgh men, J. Y. Buchanan, the chemist, and John Murray.

The *Challenger* sailed in December, 1872, and returned in May, 1876, and during that three and a half years traversed 70,000 miles of sea, dredging or trawling at 362 stations, and bringing back enormous collections, such as the scientific world had never seen. It is impossible in a few minutes to give any adequate idea of the discoveries of the *Challenger* expedition. Never did an expedition, which cost so little, produce such momentous results for human knowledge, and Edinburgh may fairly claim a share of the glory reflected from the expedition led by her famous Regius professor of natural history.

All naturalists know how great were the additions to the scientific knowledge of the oceans and their inhabitants made either during the voyage or later in the working out of the collections, which was carried on during the following twenty years, to a very large extent in Edinburgh, partly in the *Challenger* office in Queen Street, and partly in some of the laboratories of the university.

Sir Wyville Thomson did not live to see the results of his great expedition worked out and published. Soon after the return home his health broke, and he died in 1882. During the last years of his life Thomson arranged for two supplementary expeditions under Murray and Tizard to explore the Faroe Channel between the north of Scotland and the Faroe Isles. All three of our pioneers are connected with this region. Forbes long ago, in 1850, pointed out that it ought to be explored, as on the boundary of two faunas, the Arctic and the Atlantic, Thomson, in the *Porcupine*, discovered "cold" and "warm" areas at the bottom only an hour's sail apart and differing by 15° F.; and from *Challenger* temperature observations in the Pacific, etc., he predicted that a barrier would be found rising to 200 or 300 fathoms. Hence the *Knight-Errant* and *Triton* expeditions, in which Murray and Tizard discovered the "Wyville-Thomson" ridge separating cold Arctic water from warmer Atlantic.

For a quarter of a century after the *Challenger* expedition Edinburgh was the chief centre of oceanographic research, and the Mecca towards which marine biologists from all over the world turned to inspect the novelties of the wonderful collections and to discuss results, and in all this work many well-known Edinburgh men of science—Turner, Tait, Crum Brown, Geikie, Chrystal, Buchan, and others—played a leading part—outside the biological group of workers at the *Challenger* office.

After Sir Wyville Thomson's death it was fortunate for science and for the continuance of the influence of Edinburgh upon oceanographic research that Dr. John Murray, who had been chief assistant at the *Challenger* office since the return of the expedition, was able and willing to take up the directorship and bring the whole work to a most successful issue twenty years later. These two Scots share the honour of having guided the destinies of what is still the greatest oceanic exploration.

John Murray, though born in Canada, was of Scottish descent, and came as a boy to Scotland to complete his education. He also started as a student of medicine at the University of Edinburgh, and, again like his two forerunners, gave up medicine for science, and left without graduating. His first oceanographic expedition was to Spitsbergen and other parts of the Arctic regions on board a Peterhead whaler, on which, on the strength of having been once a medical student, he was shipped as surgeon. It was only an odd chance that led to Murray's connection with the *Challenger*. The scientific staff had already been definitely appointed when at the last moment one of the assistant naturalists dropped out, and on the recommendation of Prof. Tait, Murray was offered the vacant post.

On the expedition Murray devoted special attention to coral reefs, bottom deposits, and plankton, all of which have led to important results.

Murray's investigation of deposits led, moreover, to one of the romances of science when he discovered and exploited a very valuable phosphatic deposit on Christmas Island in the Indian Ocean. He was able to show, after some years' working of the deposit, that the British Treasury had received in taxes and royalties considerably more than the total cost of the *Challenger* expedition. Even in his busiest years at the *Challenger* office Murray never gave up work at sea. In his little yacht, *Medusa* (38 tons), between 1884 and 1892 he explored the sea-lochs of the west of Scotland, made great collections and many observations, and found "Boreal outliers" in Loch Etive and Upper Loch Fyne.

It is curious that Edinburgh, so favourably situated on the Firth of Forth, and provided with such a succession of eminent professors as her university has had since the days of Jameson, has never had a permanent marine biological station. Murray at least made an attempt. In 1884 he acquired Granton quarry and moored in it the *Ark* with biological and chemical laboratories. Murray and Irvine carried on chemical work while the *Ark* was at Granton on the secretion of carbonate of lime, on the solu-

tion of carbonate of lime in sea-water, and on chemical changes in muds, etc.

Murray's last oceanographic expedition was a four-months' cruise in 1910 in the North Atlantic with Dr. Hjort in the *Michael Sars* when in his seventieth year. He was killed in a motor accident in March, 1914.

There is, no doubt, other Edinburgh work in connection with oceanography, such as that of the Fishery Board for Scotland, which should be mentioned, and other names of those who are still happily with us and at work, such as the indefatigable arctic and antarctic explorer, Dr. W. S. Bruce, the leader of the *Scotia* expedition, and the founder of the Edinburgh Oceanographic Laboratory; but in this brief record of the past it has been possible only to deal simply with the historically connected work of the three great pioneers of the nineteenth century—Edward Forbes, the dredger of the shallow waters; Wyville Thomson, the explorer of the deep seas; and John Murray, who may be regarded as the founder of modern post-*Challenger* oceanography—in demonstrating the effect of Edinburgh men and ideas and work in advancing our knowledge of the science of the sea.

Absorption Spectra.

By PROF. E. C. C. BALY, C.B.E., F.R.S.

WITHOUT doubt the study of absorption spectra, more particularly those of organic compounds, has given rise to great interest, owing to the possible connection between absorption and chemical constitution. The work of Hartley, Dobbie, and others showed that in certain cases it was possible to determine the constitution of substances from observations of their absorption spectra. It is not surprising that, as the result of this work, a school of thought was founded on the basis of a direct correlation between the atomic structure of a molecule and its absorption spectrum. On the other hand, Hantzsch, who in a great number of papers has maintained the opinion that the absorption curve is an index to constitution, has travelled far beyond the original point of view. He found that changes in the absorption spectrum of a compound are observed when no change is possible in its primary valency structure, and in interpreting his results Hantzsch has invoked the aid of the secondary valencies of the atoms.

It is now known beyond any question of doubt that one and the same substance under different conditions can show different absorption spectra in the visible and ultra-violet. It is also known that, whilst a change in the primary structure of the molecule might possibly be accepted as an explanation of this in a few instances, the large majority of these variations in absorption cannot in any way be thus accounted for. Attempts were also made to interpret absorption spectra by oscillating linkages, such, for instance, as the equilibrium between the enolic and ketonic forms of ethyl acetoacetate or the oscillation that may be accepted as taking place within the benzene ring. This suggestion was very soon negatived when it was found that many substances in which no such oscillation is taking place exhibit well-marked absorption bands. For example, it might be possible to explain the ultra-violet absorption band of acetone by attributing it to the equilibrium $CH_3—CO—CH_3 \rightleftharpoons CH_3—C(OH)=CH_2$; but hexamethylacetone, in which no such change is possible, exhibits the same absorption band as acetone.

The only other possible variable from the point of view of the chemist is the secondary valency, and this has been advanced by Hantzsch and others as the explanation of absorption in the visible and ultra-violet, the well-established differences in absorption being accounted for by different distributions of the secondary valencies. No physical explanation, however, has been offered of the assumed correlation between the secondary valency and absorptive power, a matter of great importance, since a theory cannot hold good unless some physical basis can be found for the phenomenon of the absorption of radiant energy.

In all this work the study of absorption spectra of organic compounds has been restricted to the visible and ultra-violet regions of the spectrum, and, indeed, only to that portion of the ultra-violet which is transmitted by a quartz spectrograph working in air. This is unfortunate, since the absorption bands exhibited by the compounds in that vast region known as the infra-red and in the extreme ultra-violet are ignored. Then, again, many inorganic substances show absorption bands which are exactly similar to those on which Hantzsch founds his valency formulæ of organic compounds, and obviously an identical explanation must be found for each class of compound. It is not too much to say that all the above theories have been based on insufficient data.

If the complete system of absorption bands shown by a compound over the whole spectrum is examined, it is found that the central frequency—namely, the frequency for which the absorptive power is the greatest—in any visible or ultra-violet band is always an exact multiple of the frequency of an important absorption band in the short-wave infra-red. Then, again, this infra-red frequency is itself an exact multiple of the central frequencies of well-marked bands in the long-wave infra-red. This integral relationship is of great importance, since it can readily be proved that the central frequencies are truly characteristic of the molecules, the subsidiary frequencies associated with them being probably due to the atoms and groups of atoms composing the molecules. Again, the changes in absorption ex-

hibited by one and the same substance under different conditions are restricted to the visible and ultra-violet, the fundamental short-wave infra-red frequency remaining the same.

There is one point about absorption spectra which has been strangely neglected in all theories—namely, the ultimate destination of the energy that is absorbed. It is obvious that when a substance exhibits an absorption band energy is being absorbed, and if no photochemical change is thereby produced the whole of the absorbed energy is again radiated in the infra-red. The integral relationship between the frequencies is in harmony with an energy quantum theory, since, if the quantum of energy is the product of the frequency into a constant, one single quantum absorbed at one frequency can be radiated as an exact number of quanta at a smaller frequency if the first frequency is an integral multiple of the second.

The usually accepted basis of all theories of absorption is the assumption that a molecule is characterised by certain definite frequencies or free periods of vibration, and that absorption of energy takes place as the result of these. There are, however, certain objections to this assumption, such, for instance, as the fact that the frequencies of a molecule are far larger than those of the atoms which it contains. These objections can at once be met by making an entirely different assumption—namely, that a molecule is characterised by an amount of energy which determines its frequency. The cardinal assumption may be made that each elementary atom is characterised by a fixed amount of energy or elementary quantum which is associated with a definite physical process such as the shift of an electron from one stationary orbit to another. These elementary quanta are related together in that they are multiples of a fundamental unit, possibly the elementary quantum of the hydrogen atom. On this hypothesis an atom can only absorb or radiate one or more of its elementary quanta.

It may readily be shown, on the grounds that when two or more atoms combine they each lose an equal amount of energy, that the resulting molecule is endowed with a molecular quantum which is a multiple of the least common integral multiple of the elementary atomic quanta of its atoms. If the physical process in the atom occupies a definite time, assumed the same for all atoms, then all atoms and molecules will have the power of absorbing or radiating energy of a definite frequency. In all probability the molecular quantum establishes the fundamental molecular frequency in the short-wave infra-red of which the visible and ultra-violet frequencies are exact multiples. On this theory, therefore, a molecule, like an atom, can lose or gain energy as a whole only in terms of its molecular quantum.

There is little doubt that the origin of the affinity between atoms which causes them to combine is to be found in their electromagnetic-force fields, and when the combination has taken place the external faces of the atoms must come into play. These cannot exist in any molecule without mutual influence, and, indeed, the force lines must condense with the escape of energy to form a molecular-force field on which the reactivity of the molecule will depend. Obviously, this energy loss is a process in which the molecule as a whole takes part, and consequently the energy will be lost in molecular quanta. A freshly synthesised molecule, therefore, must pass into one of a number of possible phases according to the number of quanta that have been lost. It is a matter of simple proof that when a freshly synthesised molecule loses x molecular quanta in this way it becomes endowed with a new quantum which is $x+1$ times the molecular quantum. The molecular phase, therefore, will exhibit its characteristic frequency together with a phase frequency which is an integral multiple of the molecular frequency.

The total number of molecular quanta that are evolved in the force-field condensation will depend on the nature of the external fields of the atoms. The more nearly balanced these are, the greater the number of molecular quanta that will be lost. The great majority of organic compounds have a molecular frequency of the order of 1×10^{14}, so that if four quanta are lost in the force-field condensation, the phase frequency will be 5×10^{14}, which is situated in the red; but if 10 quanta are lost, the phase frequency will be $1{\cdot}1 \times 10^{15}$, which is in the ultra-violet. Again, if 17 quanta are lost, the phase frequency will be $1{\cdot}8 \times 10^{15}$, which is situated in the extreme ultra-violet beyond the limit of the quartz spectrograph.

It is perfectly possible to change the phase in which a molecule exists by supplying to it or taking from it energy in an amount equal to one or more molecular quanta. This can be done in many cases by use of a suitable solvent, or even by a change of physical state, such as from liquid to gas. The change in phase is indicated by a change in the position of the absorption band in the visible or ultra-violet, and this phenomenon is frequently observed when different solvents are used. The change of molecular phase with change in physical state is well instanced by piperidine and pyridine. Liquid piperidine is diactinic to all the visible and ultra-violet rays transmitted by a quartz spectrograph, because its absorption band lies in the very extreme ultra-violet. Piperidine vapour, on the other hand, exhibits a strong absorption band in the near ultra-violet. The absorption bands of liquid and gaseous pyridine are also quite different.

The molecular-phase hypothesis clearly has a quantitative basis, since the molecular quantum evolved in the phase change is given in ergs by the product of the frequency into the time constant $6{\cdot}57 \times 10^{-27}$. It applies, moreover, to inorganic substances as well as to organic, and of this a typical instance is given by sulphur. It is now accepted that the allotropes of sulphur are equilibrium mixtures of four different molecular species of sulphur, S_λ, S_π, S_ϕ, S_μ, and there is little doubt that these are in reality four molecular phases, for they exhibit absorption frequencies which are multiples of the fundamental molecular

frequency of sulphur. It is well known, too, that coloured forms can be obtained of many simple salts which normally are colourless, such as sodium chloride, by supplying energy to them.

The phenomena of fluorescence and phosphorescence are also due to molecular phases. If a molecule absorbs a phase quantum which, for instance, is ten times the molecular quantum, this energy can be radiated in two ways. It may either be radiated as 10 molecular quanta, when the fluorescence will be in the infra-red, or it may be radiated partly as one quantum characteristic of a lower phase—say, that phase with frequency five times the molecular frequency—and partly as molecular quanta. In the second case the fluorescence will be visible.

Since the essential characteristic of the phases of a molecule from the chemical point of view is their force fields, the variation in which causes their different reactivities, it might be argued that this theory is only a re-statement of the secondary valency hypothesis. Such an argument would not, however, be sound, for the secondary valency hypothesis does not explain absorption. At best it only succeeds in showing that different distributions of secondary valency can generally be written where the same molecule has been found to exhibit different absorption under different conditions. The present theory establishes the existence of different phases of any inorganic or organic molecule, each of which has its own energy content, its own reactivity, its own frequency and power of absorbing light. The theory attempts to correlate all the phenomena of absorption and to place them on a quantitative basis, and in this attempt it would seem to meet with some success. Although in this article we are not concerned with the chemical aspect of the differences in the force fields of the phases, it may also be claimed that this theory offers a quantitative explanation of the phenomena of reaction and reactivity.

Artificial Production of Rain.

By DR. HAROLD JEFFREYS.

IN an article in the *Times* of October 17 an account is given of the achievements of Mr. Charles M. Hatfield in producing rain. The method used is not described in any detail. A tank filled with certain unspecified "chemicals" was exposed at a height of 25 ft. above the ground, and it is claimed that this had the effect of producing 8 in. of rain in three months at Medicine Hat, 22 miles away. The theory of the method is that the apparatus draws clouds from other parts to the Medicine Hat district and causes them to precipitate their moisture there. No direct observations of the motions of clouds are mentioned in confirmation of this theory, though they should not have been difficult to obtain.

The official raingauge at Medicine Hat during May, June, and July, the period of the contract, recorded 4·8 in., which was 1·3 in. below the normal for the station for those months. Further comment on the success of the experiments is unnecessary.

The financial side of Mr. Hatfield's contract with the United States Agricultural Association of Medicine Hat is interesting, for the association was apparently prepared to pay Mr. Hatfield as if 8 in. of rain had fallen. Still more interesting is the fact that he was promised 4000 dollars for 4 in., and 6000 dollars for 6 in. Since the normal rainfall is 6·1 in., Mr. Hatfield would have been much more likely than not to make a substantial profit even if he had done nothing at all.

It may be mentioned that at Calgary, Alberta, the rainfall was 3·0 in. below normal; at Edmonton it was 3·1 in. above; and at Qu'Appelle (Sask.), 300 miles to the east, it was 3·85 in. above normal.

It is also stated that at Los Angeles, in the first four months of 1905, Mr. Hatfield guaranteed 18 in. of rain, and that his own raingauge showed 29·49 in. If this is correct the rainfall must have been extremely local, for the official raingauge at Los Angeles in those months showed only 14·98 in. Still, this was 4·4 in. above normal. At San Diego, however, which is 200 miles away, the excess was 4·6 in., and it appears likely that the abnormality at both stations was due to more widespread causes than Mr. Hatfield's chemicals.

Attempts have on many previous occasions been made to produce rain by artificial means, but the results have been uniformly unsuccessful. The reason is not difficult to see. To make the water vapour in the air condense it is necessary to cool the air in some way to a temperature below the dew point. This may be done in two ways. One may cool the air directly, for instance by the evaporation of liquid carbon dioxide or liquid air. This certainly would produce a little condensation; the fatal objection to it is that it would be thousands of times cheaper to distil sea water. The other method is to raise the air. The pressure decreases with height, and to reduce the pressure on a particular mass of air is known to cool it. The difficulty is to raise it enough. To produce an inch of rain over an area of 100 square miles requires the condensation of 6 million tons of vapour, and to achieve this some hundreds of millions of tons of air must be lifted up. The distance it must be raised depends on how nearly saturated it was originally, but it could not be less than a kilometre in ordinary fine weather conditions. We have no source of energy at our command great enough to achieve this.

It is often suggested that rain may be produced

by exploding shells or otherwise agitating the air. The action is compared with that of a trigger, a large amount of energy being released by a small effort. An essential feature is, however, overlooked. For a trigger to work, there must be a large supply of potential energy only awaiting release. Precipitation from partially saturated air would require an actual supply of new energy. Therefore a trigger action cannot produce precipitation.

Obituary.

Prof. Ch. François-Franck.

CH. FRANÇOIS-FRANCK, the distinguished physiologist, and officer of the Legion of Honour, who passed away in September last at the age of seventy, was the successor, at the Collège de France, of Marey, whose assistant he had been from the time of his arrival from Bordeaux to work for the degree of Doctor of Medicine. The acquaintance was most fortunate. Marey, always in more or less delicate health and naturally desirous of saving his strength, seldom delivered the annual course of forty lectures which necessitated so much original work—for the lectures of the Collège de France are not given for the instruction of students in preparation for examinations, but to further the advancement of science. Marey continued in his own laboratory that admirable series of experiments on the flight of birds, the motions of the horse and man, and the compilation of his book, "La Méthode Graphique," of universal renown.

François-Franck was therefore appointed by Marey to lecture in his stead, and thus he gained the opportunity of doing original work for the foundation of the lectures. His subject was the physiology of the circulation in general and of the heart and lungs in particular; and for more than thirty years François-Franck delivered the course of lectures annually. The number of experiments he made must have been enormous, for all the lectures were illustrated on the board in the room by means of most ingenious apparatus and registering instruments. The talent for exposition he possessed and the extreme precision of the details and results he showed were never forgotten by those who attended the lectures.

It was in another department of physiology that François-Franck accomplished his *magnum opus*, "La Physiologie du Cerveau," published in 1887. He was on intimate terms of friendship with Pitres, afterwards the distinguished professor of neurology at Bordeaux, who, coming with François-Franck to take the degree of Doctor of Medicine in Paris, had gone direct to Charcot at the Salpêtrière. At that time Charcot was working very hard to establish what he called "la belle doctrine" of cerebral localisation, and Pitres became his most enthusiastic and useful assistant. He engaged the interest of François-Franck in this field of work, and they began a series of experiments which ultimately was continued and terminated by François-Franck alone. The work is a remarkable production, as physiologists know, both for the originality of treatment and the extreme precision of the experiments. François-Franck also published a number of articles in the "Dictionnaire des Sciences Médicales" of Dechambre that are models of lucidity and sound learning, on the sympathetic nervous system, besides more than eighty papers or notes in the "Comptes rendus de la Société de Biologie," the meetings of which he seldom missed; he had also been a vice-president of this society. The reputation he had gained amongst physicians was such that he had become a much-sought consultant for heart and circulatory disorders and diseases, although he was never connected with any hospital.

François-Franck lived in retirement for the last few years owing to failing health, and was much missed by his scientific friends. Some twenty years ago the Academy of Medicine had most justly elected him to take a seat near the masters, Marey and Channeau, for he was the one man in France who was able to demonstrate in detail the great work of these physiologists who established the unalterable foundations of our knowledge of the functions of the heart and the circulatory organs.

E. J. Bevan.

Mr. Edward John Bevan, who died suddenly on October 17, in his sixty-fifth year, was educated at private schools, and at the age of seventeen entered the laboratory of the Runcorn Soap and Alkali Co. Thence, in 1877, he proceeded to Owens College, Manchester, where he met Mr. C. F. Cross, and the student friendship continued after the college career, each entering upon research work in connection with cellulose industries, upon which they kept up an active correspondence and a certain amount of collaboration. This resulted in a definite joint adventure, and the work was continued at the Jodrell Laboratory, Kew Gardens.

The publication of results in the Journal of the Chemical Society (1882–83) led to a research appointment with the firm of Thomson, Bonar and Co., actively engaged in the pioneer development of the "Ekman" wood pulp (cellulose) process; the work was undertaken under the formal partnership "Cross and Bevan." They were next engaged in technical research work in connection with textile bleaching processes—the "Thompson" process, the "Hermite" electrolytic process—and as a necessary incident prosecuted investigations of the alkali-boiling treatments by which

the textiles are prepared. These investigations were the chemical basis of the invention of the well-known "Mather" Kier and process. In 1885 "Cross and Bevan" was established at 4 New Court, Lincoln's Inn, where the scientific-technical research work has been carried on ever since. The invention of the well-known "Viscose" process in 1892 resulted from the systematic investigations of the antecedent period.

The development of this matter becoming a pressing question of "ways and means," Mr. Bevan decided to enter the field of professional chemistry, and obtained the appointment of County Analyst for Middlesex. In this field he made his particular personal reputation. The long tenure of this important position (1892–1921) is evidence of Mr. Bevan's exceptional qualifications, and in addition to those of chemist his qualities of character, brought to bear on activities associated with his office, were honoured by influential positions in the Institute of Chemistry (vice-president) and Society of Public Analysts (president).

Mr. Bevan's life-work is a many-sided constructive contribution to chemical science, and his career may be an encouragement to young students of this generation who are inclined to despise the day of small beginnings.

THE third EARL OF DUCIE, who died on October 28, aged ninety-four, was much interested in natural science, and was for many years an active geologist. He joined the Geological Society in 1853, and was a member of council from 1856 to 1858. He collected fossils, and between 1864 and 1891 made many valuable gifts of specimens to the British Museum. He also made important observations on the geology of the region round Tortworth, Gloucestershire, his country seat. He was elected a fellow of the Royal Society in 1855.

THE death occurred on Friday, October 28, at the age of forty-two years, of PROF. F. E. ARMSTRONG, professor of mining at the University of Sheffield.

WE regret to announce the death, on Thursday, October 27, at the age of forty-seven years, of PROF. F. A. BAINBRIDGE, professor of physiology in the University of London.

WE much regret to see the announcement of the death on October 29, at the age of fifty-four years, of DR. W. S. BRUCE, the well-known Polar explorer and naturalist.

Notes.

ON Monday last, October 31, twenty-five years had elapsed since Prof. P. Zeeman's first observations of the decomposition of spectral lines by a magnetic field were communicated to the Amsterdam Academy of Sciences in a paper that appeared shortly afterwards in the *Philosophical Magazine* under the title "On the Influence of Magnetism on the Nature of the Light emitted by a Substance." By this important advance in magneto-optics, the first made since the days of Faraday and Kerr, a new and vast field of research of uncommon interest was opened. In commemoration of this development a reprint of Prof. Zeeman's original papers has now been published by the physicists of the Netherlands, conjointly with many scientific men of other countries. Prof. Zeeman has also been honoured by a special issue of the Dutch journal *Physica*, containing contributions by C. Cotton, G. E. Hale, Ph. Kohnstamm, T. van Lohnizen, H. A. Lorentz, A. van Maanen, E. E. Mogendorff, H. Kamerlingh Onnes, F. Paschen, and C. Runge. Some of these articles are devoted to an appreciation of Zeeman and his work or to the history of his discovery. In others the present state of magneto-optical theory and the latest results in the experimental investigation of the Zeeman effect are discussed. The bearing of the phenomenon on solar physics and the conclusions that have already been drawn concerning the magnetic field of sun-spots and the sun's general magnetic field are explained by Prof. Hale and Mr. van Maanen. Finally, Prof. Paschen describes a new phenomenon lately discovered by him, and consisting in the appearance, under the influence of a magnetic field, of certain spectral lines that cannot otherwise be produced. We are glad to avail ourselves of this opportunity of expressing our high appreciation of Prof. Zeeman's brilliant work, by which he has contributed most effectively to the development of modern physics.

"Is it advisable that every clinical thermometer offered for sale in Great Britain should be tested at the National Physical Laboratory?" This is the question asked and answered affirmatively in a circular issued by the British Lampblown Scientific Glassware Manufacturers Association and circulated amongst members of Parliament, the medical profession, etc. It is pointed out that from the consumer's point of view it is as important to be assured that the clinical thermometer he buys is accurate within two-tenths of a degree Fahrenheit as it is to have a guarantee, such as the law provides, that when he purchases butter it is pure butter that he gets. From the maker's point of view it is to the good of the trade in this country that there should be such a standard of accuracy of clinical thermometers that everyone will know the British article to be above suspicion. When the Government made testing compulsory, at least 25 per cent. of the first batches tested were rejected as inaccurate; but there was steady improvement until, at the time of the abolition of the compulsory test, the rejections were of the order of only 1½ per cent. The quantities under test, which in November, 1919, when testing was compulsory, were 135,000 per month, dropped to 55,000 per month in June, 1921, when the compulsory test was abolished. In view of these results the British Lampblown Scientific Glassware Manufacturers Association invite support of

the Clinical Thermometer Bill, which was submitted to Parliament in July last to replace the lapsed Order in Council, but which, owing to the objections of six members, was deferred by the Government to the next session. That in the interests of consumers and manufacturers alike there should be some guarantee of accuracy seems to be indisputable. The circular does not discuss the question whether clinical thermometers imported from abroad and tested by a foreign institution of recognised standing should also be re-tested by the National Physical Laboratory before being sold in this country.

THE Church of St. Martin's-in-the-Fields, the bicentenary of which is about to be celebrated, was rebuilt in 1721, but, as was pointed out by Sir William Tilden in NATURE of October 6, p. 176, it was not in the present church that Boyle was buried. It was, however, in the vaults of the new church that the great anatomist, John Hunter, was first interred. Hunter's burial took place in October, 1793, and the transference of his remains to Westminster Abbey sixty-six years later was entirely due to the extraordinary exertions of Frank Buckland, the naturalist. Buckland's resolution to do honour to Hunter's remains was made at a dinner held in 1856 to celebrate the centenary of Hunter's studentship. Three years later, on February 7, 1859, he began to search the vaults of St. Martin's for Hunter's coffin, and in his diary writes:—"Moving coffins all day long; turned out about thirty coffins. . . The stink was awful; rather faint towards the end of the business." His search went on for fourteen days, until on February 22 he records:—"At work all the morning, and about three o'clock in the afternoon found it, the bottom coffin in the last tier but one." The removal of the coffin to the Abbey took place about a month later.

THE *British Medical Journal* announces that the Municipal Council of Paris has decided to establish at a cost of 1,185,000 francs a municipal institute of electrotherapy.

SIR ARTHUR GRIFFITH-BOSCAWEN, Minister of Agriculture and Fisheries, has appointed the Earl of Ancaster to act on his behalf as Deputy Minister of Fisheries in addition to his duties as Parliamentary Secretary to the Ministry.

THE *Times* of November 1 announces that Mrs. Rosita Forbes (Mrs. McGrath) was presented with the gold medal of the Antwerp Royal Geographical Society on Saturday last after she had given a lecture to the society on her expedition to Kufara.

DR. M. GRABHAM, of Madeira, will deliver the Bradshaw lecture at the Royal College of Physicians on November 3 on "Sub-tropical Esculents" and Dr. R. O. Moon the FitzPatrick lectures on November 8 and 10 on "Hippocrates in Relation to the Philosophy of his Time."

THE Swiney lectures on geology for the present year will be delivered by Dr. J. D. Falconer at the Imperial College of Science and Technology (Royal College of Science, Old Building) on Mondays, Wednesdays, and Fridays, beginning on November 7, at 5.30. There will be twelve lectures in all on the subject of "The Wonders of Geology." Admission will be free.

PROF. J. W. HINCHLEY, of the Imperial College of Science and Technology, South Kensington, has issued invitations to a meeting to be held on Wednesday, November 9, at the Engineers' Club, 39 Coventry Street, London, W.C., to discuss the best method of forming an Institution of Chemical Engineers. Sir Arthur Duckham will preside, and will be supported by representatives of various branches of industrial activity cognate with the profession of chemical engineering.

THE sixth meeting of the Optical Society of America was held at Rochester, N.Y., on October 24, 25, and 26, and was constituted an Helmholtz memorial meeting. On the first day the president, Prof. J. P. C. Southall, gave a brief survey of the development of optics, Prof. H. Crew gave an account of Helmholtz's work on the conservation of energy, Dr. L. T. Troland of his contributions to physiological optics, and Prof. M. I. Pupin gave some personal recollections of him. Under the chairmanship of Mr. P. G. Nutting, the reports of sixteen subcommittees on nomenclature and standards were read and discussed. Up to the present time these reports have not been received, but from the abstracts of some of them which are available it is evident that they will be of importance to optical workers in this country.

IN the third interim report of the Departmental Committee on Lights on Vehicles it is remarked that complete elimination of dazzle from motor headlights is impracticable, but glare may be materially restricted below the eye-level of an adult observer approaching a car. The main beam should accordingly be restricted as regards height above ground and a maximum and minimum intensity specified. Secondary diffused light should be also available. No lamp entirely complying with the desired conditions has been found. Suitable regulations permitting the use of existing lamps adapted to restrict light below a height of 4 ft. from the ground and diffuse the light are proposed, but would require statutory authority. Compliance would involve co-operation on the part of manufacturers and owners of headlights, which should be submitted to an approved authority which might issue certificates. No legal requirement of minimum intensity exists, and the Committee consider that this should not be made compulsory, but that in any proceedings in regard to dangerous driving due regard should be paid to adequacy of lights. Swivelling headlights should not be permitted, but devices enabling the beam to be tilted downwards to avoid dazzle are permissible provided all headlights execute the same movement. Inspection lamps, for use only when the vehicle is at rest, should also be permitted.

THE Journal of the American Society of Naval Engineers for August last contains an interesting and well-illustrated article by Comdr. Stanford C.

Hooper, U.S.N., on the Lafayette super-high power radio station. The station is situated at the small village of Croix d'Hins, sixteen miles south-west of Bordeaux, and the memorial tablet states that it was "conceived for the purpose of ensuring adequate and uninterrupted Transatlantic communication facilities between the American Expeditionary Forces engaged in the world-war and the Government of the United States of America." The greater part of the structural material, amounting to some 15,000 tons, was prepared in America. Work was started at Croix d'Hins on May 28, 1918, and the station was completed on August 21, 1920. Among the principal items of interest are the eight self-supporting steel towers 820 ft. in height, triangular in plan, placed in two rows, the rows and towers being 1320 ft. apart. Weighing about 550 tons, each tower is designed to withstand a horizontal pull at the top of 11 tons, while the dead-weight of the whole antennæ system supported is about 3½ tons. The transmitting equipment consists of two 1000-kilowatt arc radio transmitters complete in duplicate throughout. During the trials, signals were copied without difficulty at Cavité, San Francisco, and Darien, and it was demonstrated that Lafayette's signals could be heard at suitably equipped radio receiving stations all over the world.

THE report of the council of the North-East Coast Institution of Engineers and Shipbuilders contains the awards made for papers read during the session 1920–21. The engineering gold medal is awarded to Eng.-Comdr. C. J. Hawkes for his paper on Diesel engines. In the graduates' section awards have been made to Mr. W. S. Burn for a paper on Diesel-engine flexibility, to Mr. F. McAlister for his paper on the design of ship-form of the modern cargo-vessel type, to Mr. E. V. Telfer for a paper on the strength of ships, and to Mr. C. S. Darling for a paper on internal-combustion engines for marine purposes. Standardisation work was energetically pursued during the past session by the North-East Coast Institution Panels. The committees of the associations concerned still endorse their decision not to proceed with the formation of an engineering and shipbuilding research association, in view of the unfavourable industrial conditions. Among other gifts to the institution may be mentioned one of 250*l*. from Mr. T. A. Reed to establish a fund for the provision of an annual medal or prize in memory of his father; the details of the competition in this connection have not yet been decided upon. It is of interest to note that of the twelve entrants for the 1921 scholarship, one only has not yet matriculated; this supplies evidence of the better standard of education attained by candidates. The institution has broken new ground this session by electing a shipowner to the presidential chair, and the new president, Sir William J. Noble, in his address delivered on October 14, indicated the need for co-operation between shipowners, shipbuilders, and employees; our only light in the darkness—and it is not a very illuminating one—is that other countries are apparently just as badly off as ourselves.

IN his preface to Bulletin No. 1, of the Department of Industries, Bombay, Mr. R. D. Bell states that this is the first of a series which it is proposed to publish in order to make the public acquainted with the activities of the Department, and to place information in a convenient form at the disposal of those who can make practical use of it. This is obviously a step in the right direction, and the Department is to be congratulated on the bulletins which have already appeared. Bulletins Nos. 1 and 4 contain parts 1 and 2 of a series of papers on Indian casein, initiated and carried out by Dr. A. N. Meldrum in collaboration with Mr. D. M. Gangoli. The results obtained are clearly stated, and it is evident that this kind of work is typical of that which must be undertaken in India by competent investigators if the great natural resources of the country are to be applied to industrial purposes. It is of the greatest interest to note that the Department has recently opened a small demonstration factory at Anand, in which the manufacture of casein in accordance with the results of these investigators will be carried out on the commercial scale. Bulletin No. 2 contains an account of work by A. J. Turner on the utilisation of bitterns, in which it is shown that the whole of the magnesium chloride required for cotton weaving, etc., can, if desired, be obtained from Indian sources, and need not be imported, as is at present the case. Moreover, it appears that the price of Indian salt would be considerably less than that of the foreign article. Hitherto the vast salt deposits at Kharaghoda, with which this paper deals, have received little attention, although recent analyses seem to show that they are comparable with the Strassfurt deposits in wealth of material, and that, if properly worked, they could render India self-supporting so far as potash, bromine, and magnesium salts are concerned. It is therefore welcome news to hear that this mine of wealth is at length being investigated, and that some, at least, of the recommendations of the Chemical Services Committee are receiving attention.

OF special interest to students of plant physiology is the recently issued instalment of the section on methods of investigation of the functions of the plant-organism forming Abteilung 11, Teil 2, Heft 1, of the "Handbuch der biologischen Arbeitsmethoden," edited by Dr. E. Abderhalden, of Halle University. The author, Viktor Grafe, of Vienna, deals with the following subjects:—The physico-chemical analysis of the plant-cell; the determination of permeability in plant-cells; use of adsorption and capillarity for biochemical analysis; and measurement of the processes of movement of gas and water in the plant-organism. Various methods of experiment are described and illustrations are given of the apparatus employed.

MR. W. JUNK, of Berlin, has issued a list of a remarkable collection of botanical works, containing altogether 12,900 hand-coloured plates, which he offers for sale as a whole to the highest bidder. Should no satisfactory offer for the whole be received, offers for single works may be considered. The collection includes some of the finest and rarest illustrated works

on botany. Some of them are unique, the plates being copies of the original issues, executed by R. Simkó, an Hungarian painter, while the text is neatly typewritten. This is the case with Sibthorp's "Flora Græca," the 966 plates of which have been redrawn, apparently with extraordinary success, for they are described as being more artistic than those of the original issue, the merits of which are well known. Several of Jacquin's rare works are included in the collection, amongst them being his "Hortus Botanicus Vindobonensis," "Flora Austriaca," and "Icones Plantarum Rariorum." There is also a complete set of W. Griffith's "Posthumous Papers," Waldstein and Kitaibel's "Descriptiones et Icones Plantarum Rariorum Hungariæ," Reichenbach's "Iconographia Botanica," and "Icones Floræ Germanicæ et Helveticæ," Lapeyrouse's "Figures de la Flore des Pyrénées," and Weinmann's "Phytanthozaiconographia."

IN *Science Progress* (No. 62) Mr. F. W. Flattely, in an article on "Some Biological Effects of the Tides," discusses the consequences which tides and tidal action have had on the life of the sea-shores. The abundance of sedentary or fixed forms and the widespread occurrence of the phenomenon of stereotaxis among free-swimming species are traced to the direct action of wave impact. Reference to such semi-marine animals as Ligia, certain species of Littorina, Birgus, and Periophthalmus, is made to show that the population of the land from the sea took place *via* the shore as well as by way of the rivers, and it is suggested that the daily and monthly changes in tidal level, by producing alternating aquatic and terrestrial conditions, made the shore zone an effective bridge between the land and the sea, and provided the opportunity for marine animals to attempt the conquest of the land. The case of Convoluta is quoted to show that the daily rhythm of the tides has imposed a periodicity upon the behaviour of shore forms which tends to become impressed on the animals and to persist after their removal from tidal influence. The far-reaching consequences of such an effect on animal behaviour are suggested rather than insisted on.

IN a paper in the *Philosophical Magazine* for September Drs. Dorothy Wrinch and Harold Jeffreys discuss some of the fundamental principles of scientific inference. They assume that scientific arguments must conform to the rules of pure logic—an assumption which, of course, is by no means universally admitted. They then inquire what conditions must be fulfilled in order that a proposition shall have a finite probability of truth as the result of empirical verification, the term "probability" being used in a sense which they have expounded in a previous paper (*Phil. Mag.*, December, 1919). They conclude that if all possible forms of the law are equally probable *a priori*, then no amount of empirical verification can establish a finite probability in favour of one law rather than another. In order that a finite probability may be established it is necessary that the class of possible laws should form a well-ordered series in which each term is more probable *a priori* than its predecessor, and that the probabilities of this class form a convergent series. The supposition that this necessary condition for valid scientific inference is fulfilled is equivalent to the admission of some principle of "simplicity." Thus, like most of those who discuss the foundations of science, they arrive at very familiar conclusions as a result of very complicated arguments, but that result does not detract from the value or the interest of their inquiries.

THE Greenwich observations for the twelve months from October, 1920, to September, 1921, give 12·43 in. as the total rainfall, which is only 51 per cent. of the normal for the last hundred years. This is the smallest amount on record for the corresponding period, the next smallest being apparently from October, 1897, to September, 1898, when the fall was 14·75 in., or 60 per cent. of the normal. For deficiency this was followed by 16·74 in. from October, 1863, to September, 1864, which is 69 per cent. of the hundred-year normal. The rainfall has been below the average in each of the last thirteen months. This is the longest dry period in the last hundred years with the single exception of fifteen months from November, 1846, to January, 1848, during which time the rainfall for the twelve months from November, 1846, to October, 1847, registered only 16·26 in. October is usually the wettest month of the year, but this year it had a deficiency of more than 1½ in. Different weather conditions prevailed in the early and latter halves of October; the first half of the month experienced summer weather, while in the latter half the weather was cooler and less sunny. Each day from October 1 to 15 was abnormally warm; the mean daily excess over the normal was 10·7° F., the greatest excess being 17° F. on October 6, and there were eight days with an excess of 13·7° F. or more. The duration of sunshine at Greenwich from October 1 to 15 was 101 hours, which is 4 hours more than the normal for the whole month.

THE Department of Commerce, Bureau of Standards, Washington, has issued Scientific Paper No. 416, entitled, "Preparation of Galactose." Owing to the demand made by bacteriologists for galactose and its derivatives, a convenient method is described for preparing this compound from lactose. One kilogram of lactose is hydrolysed by boiling for two hours with 2·5 litres of water and 50 grams of sulphuric acid. The solution is neutralised with barium carbonate, filtered, and concentrated. The galactose is crystallised from the resulting syrup by the addition of a mixture of one part of ethyl and two parts of methyl alcohol. The yield of crude sugar is about 27 per cent. of the lactose taken. The galactose is purified by concentrating to 75 per cent. of total solids, under diminished pressures, a 25 per cent. solution to which a little glacial acetic acid is added. The material is warmed to 60–70°, transferred to a beaker, and 95 per cent. alcohol added to saturation. After standing overnight the crystals are filtered, washed, and dried.

THE presidential address delivered by Mr. G. W. Watson on October 12 last, at the Institution of

Automobile Engineers deals with the subject of industrial standardisation. A little standardisation had been accomplished subsequent to 1910, but the year 1914 found us in a condition of partial impotence, and gave the "component assemblers" in America their opportunity for reaping a rich harvest. Co-operation in this and other matters with a view to the re-establishment of trade is urgent at the present time. Hitherto British industry has been more or less indifferent to the question of standardisation; many directors have been, and still are, apathetic in the matter, and vote money for standardisation more in the spirit of charity donations than as matters of important business. Mr. Watson considers it would be best for British makers to concentrate on the standardisation of commonly applicable details rather than to attempt to produce vehicles alike in all particulars. Abroad there will always be found an appreciable percentage of distinctive British-built cars owned by discriminating users. Standardisation in foreign countries is making great strides; indeed, there are now standards committees in thirteen different countries. A Standards Committee of German Industry was formed three years ago, and in two years had issued 160 standard sheets and had more than 400 in progress.

MESSRS. H. K. LEWIS AND CO., LTD., have just issued a list of additions to their Medical and Scientific Circulating Library for the months July–September. The catalogue should be of service to all students of science, whether subscribers to the library or not.

MESSRS. GURNEY AND JACKSON will shortly publish "The Natural History and Physical Features of the Canary Islands: Their Fauna, Flora, and Geological Formation." The work, which will be illustrated by reproductions of photographs and maps, will deal especially with the ornithology of the islands.

WE have received a copy of a short paper "On Correlation," by Alf Guldberg, from the Norsk Matematisk Forenings Skrifter. The paper (written in English) criticises the divergent definitions of correlation that have been given, and suggests cautions as to interpretation, but there does not appear to be much novelty in the views of which an exposition is given.

Our Astronomical Column.

THE NOVEMBER METEORS.—Mr. W. F. Denning writes:—The shower of Leonids is due at the middle of November, and though the parent comet of the stream is now at a great distance from the earth (approaching us from near the orbit of Uranus) there will probably be a tolerably active exhibition of meteors.

Observations in past years have proved that certain sections of the ellipse are more rich in meteors than others, so that if we assume a period of about thirty-three years for all portions of the stream, the display of November 14, 1888, ought now to be repeated. The shower of that year was not of very special character, but it was fairly conspicuous, and furnished some large fireballs. It was, in fact, considerably more striking than an ordinary return of Leonids when Tempel's comet is far removed from perihelion.

The best time for observation this year will be the morning of the 15th, but unfortunately there will be a full moon in the sky, so that only the brighter meteors will be visible. However, the members of the Leonid stream usually supply a number of splendid objects, and tolerably bright meteors are quite a common feature. Though the conditions affecting this year's return are not therefore favourable, the event should be carefully watched, for it is important to accumulate evidence as to the visible character of the annual displays.

LIGHT OF THE NIGHT SKY.—*Scientia* of October 1 contains an article by Prof. Charles Fabry on the luminosity of the night sky. Prof. Fabry discusses whether or not this luminosity can be attributed to an unresolved background of faint stars. In this connection he insists on the importance of concentrating attention on some small selected area and determining how many stars of each magnitude are present, with a view of extrapolation to stars below the 20th magnitude, which cannot be detected by existing telescopes. The luminosity of the general background of this area should be observed concurrently. If, as appears probable, we cannot plausibly attribute the general illumination to unresolved stars, it would be natural to fall back on the hypothesis of scattered light. That the light can be due to scattering by gaseous matter appears improbable in view of Lord Rayleigh's recent observations on the colour and state of polarisation of the light of the night sky. It may, however, be scattered by meteoritic matter. The article concludes by reference to the aurora as contributing in some cases to the light of the night sky.

DELINEATIONS OF THE MILKY WAY.—Dr. F. Goos, of Hamburg University, has produced a useful series of representations of the Milky Way as delineated by various astronomers, partly from visual study and partly from photographs. The work of Heis, Gould, Easton, Boeddicker, and Houzeau has all been reduced by photography to a common scale, which is somewhat small, but sufficient to show all the important features. There is also a new delineation made by Dr. Goos himself from photographs by Prof. Max Wolf, who contributes an introduction in which he points out that photography is incomparably more rapid and convenient than visual work, but that it has difficulties of its own, as no lens covering a large field will give images of the same character on all parts of the plate; it is thus easy to draw fallacious conclusions as to the relative brightness of different regions. The exposures lasted from three to four hours, and stars down to the thirteenth magnitude are shown on the negatives. The reproductions were made by hand from the negatives and then reduced by photography. They show a large amount of complicated structure, including many of the dark rifts which may be due to opaque matter. Comparison of the different authorities reveals many differences. Boeddicker shows some faint outlying streamers, which are absent from Houzeau and shorter and fainter on the Wolf pictures. Dr. Goos suggests that colour-differences may explain some of these discordances.

The Danish Arctic Station.

By PROF. A. C. SEWARD, F.R.S.

THE Danish Arctic Station at Godhavn, on the south coast of Disco Island, off the west coast of North Greenland (lat. 69° 14′ N.), is not so well known, at least to British scientific workers, as it deserves to be. It is the only station in the world within the Arctic Circle where it is possible under very favourable conditions and with adequate facilities to carry out experimental scientific investigations.

FIG. 1.—The Arctic station, showing Archæan gneiss in the foreground and, behind, one of the mountains carved out of the plateau of Tertiary basalt sheets and beds of tuff.

In 1898 the present director, Mr. Morten P. Porsild, on his return from an expedition under the late Dr. K. J. V. Steenstrup, to which he was attached as botanist, made an unsuccessful attempt to induce the Danish Government to establish a station in Greenland. Some years later funds were obtained from private sources, chiefly from Mr. A. Holck, of Copenhagen, and Mr. Porsild, with the assistance of two Danish carpenters and some native labourers, but largely with his own hands, built the present station and established himself there in 1906. The Government at once took over the station, with Mr. Porsild as director, and made an annual grant of 10,000 kronen to cover all expenses, including the director's stipend. The director for Greenland, at present Mr. Daugaard-Jensen, an official who, under the Minister of the Interior, is responsible for Greenland affairs, has the assistance of a Commission composed of a few scientific men to advise him on all matters connected with the station.

The station is about 1 km. from Godhavn harbour, and is reached by a road, probably the best road in Greenland, made by Mr. Porsild. The station consists of a well-built and exceptionally warm wooden house of two stories approximately 20 by 10 metres in plan. On the ground floor there is a well-equipped laboratory and a dark room, a library containing about 5500 books and pamphlets, and an excellent herbarium of Arctic and some Alpine plants, and living rooms; on the first floor are two good bedrooms for visitors and a workroom. The library receives contributions from foreign institutions and from individuals in return for papers published at the station or for specimens. British authors whose work deals with subjects bearing upon Arctic problems will do good service to science by sending reprints to the director.

Near the main building is a large workshop, and an adjacent stream provides an abundant supply of excellent water. The station is built on glacial sand at the foot of the rounded hummocks of gneiss which on this part of the coast form the foothills in front of the terraced basaltic cliffs rising to a height of more than 2000 ft. (Fig. 1). On the seaward side the station faces Disco Bay, with the Crown Prince Islands in the distance, and in the foreground there are always several icebergs (Fig. 2) which have stranded on the shore after drifting across the bay from the large Jakobshavn ice-fjord.

The main objects Mr. Porsild had in view in founding the station were to provide a base for a geographical and geological survey of the country, a centre from which to investigate the fauna and flora of a particularly rich Arctic region, and means for experimental work, both biological and chemical. It would be difficult to find a more suitable place as a training school for men who wish to qualify themselves for Arctic exploration, as in winter the locality is particularly well situated for sledging and ski-ing. The station's motor-boat is available for expeditions and for marine investigations, while for shorter trips, especially to places where the anchorage is bad, visitors can hire a umyak (a long flat-bottomed skin boat).

Since 1908 there have been fourteen visitors to the station from Denmark, Sweden, Germany, Switzerland, and America, who have resided there several weeks or months, and many others for shorter periods. Forty scientific papers on work done at the station or dealing with material collected in the neighbourhood have been published, and of these twenty-five are by the director.

FIG. 2.—View from the Arctic station. Icebergs stranded on the beach of Disco Bay.

As Greenland occupies an exceptional position as a "closed" country, it is necessary for all foreigners,

also for Danes not officially connected with Greenland, to obtain permission from the Danish Government to go there. British applicants should submit recommendations through the Foreign Office and specify the purpose of their visit. There is at present no fee for working at the station, and for board and lodging the charge is at present only 8 kronen a day. The North Greenland district is accessible to ships from the latter part of May to the end of September, but during that time there are usually only two opportunities of direct connection with Copenhagen.

The director is an ideal man for the position; he is generally acknowledged to be the leading authority not only on the natural history of West Greenland, but on the history of Eskimo culture, and he is always willing unreservedly to place his knowledge and the results of his wide experience at the disposal of fellow-workers.

It was my privilege this summer, in company with Mr. R. E. Holttum, of St. John's College, Cambridge, to spend some weeks at the Arctic station, and I cannot speak too highly of the hospitality and scientific assistance which we received. Unfortunately for the cause of research, the director has no paid assistant to relieve him of much of the routine work of the station which makes serious inroads into the time available for investigations in his own special fields. One of the director's sons, Mr. Erling Porsild, who is not only a keen naturalist, but also is able to speak the Eskimo's language with ease, took us for a week's trip in the station's motor-boat to some localities where we wished to collect fossil plants. Our intention was to return to Godhavn in time for the King's visit before visiting more remote places, but the breaking of the boat's shaft and a spell of bad weather rendered this impossible, and threatened seriously to interfere with our subsequent plans. Mr. Porsild at once approached the Director for Greenland who accompanied the Royal party, and he very kindly placed at our disposal for a month's trip his official motor-boat—an act of generosity for which it is difficult adequately to express my gratitude.

The particularly favourable climatic conditions in the Godhavn district have produced an exceptionally rich and varied flora, including several southern types not found elsewhere in North Greenland. There is a legend that Disco Island once lay much further south, and as it was an obstacle to navigation a hunter towed it behind his kayak to its present position.

Mr. Porsild has taken steps to protect the vegetation in the immediate neighbourhood of the station and at Englishman's Harbour, near the warm springs, of which there are several on the south coast of Disco, by putting up notices in the Eskimo language asking the natives to abstain from gathering fuel or collecting plants for food within certain protected areas—a request which is almost invariably respected.

The Danish Government by officially adopting the Arctic station showed its appreciation of the foresight and determination of Mr. Porsild, and set an example to other nations possessing territory within the Arctic Circle. One may venture to express the hope that the State will see its way to increase the value of this pioneer station by augmenting the annual grant sufficiently to provide an adequate stipend for the director and for a trained assistant, by the provision of an additional and larger motor-boat, and by expending the comparatively small sum required to make certain much-needed extensions of the building to relieve the present congestion in the rapidly growing library, and to accommodate the very valuable collection of Eskimo implements and weapons obtained by the director in the course of excavations made by him during several years on the mainland.

Psychological Tests for Vocational Guidance.[1]

THE newly-formed section of Psychology had, at its first meeting in Edinburgh, a large and enthusiastic attendance. It opened its sittings on the morning of Thursday, September 8, being joined by the sections of Education and Economics, under the chairmanship of Sir Henry Hadow (president of the Education Section), with a discussion upon "Vocational Tests and Vocational Training." It appeared, in the course of the several speeches, that economists, educationists, and psychologists alike were agreed upon one general and practical conclusion, namely, the feasibility and the importance of diagnosing during early childhood, whether by tests or other means, each individual's special vocational aptitudes.

Sir William Beveridge (director of the London School of Economics), who spoke late in the discussion, summed up the arguments for this conclusion most clearly. With other speakers he welcomed cordially the progress of industrial psychology, and maintained that if boys could be selected with greater care for the vocations they had to take up, three distinct economic consequences might be predicted. In the first place, unemployment would be appreciably diminished; although it was impossible to expect that lack of work would be altogether abolished simply by right vocational selection, it would beyond question be very much reduced. Secondly, the tenure of employment would be more nearly permanent: one of the chief causes that prevented people from sticking to the jobs they had obtained would be largely eliminated. Lastly, productivity would be greatly increased. Besides these more limited effects, economic in their special nature, there would be a wider benefit to the public at large—a general decrease in human misery, and a general increase in human welfare.

He proceeded with some severity to criticise the method, or lack of method, now obtaining among employers in their choice of persons for different kinds of occupation. There were few things, he said, which employers handled more inefficiently than the selection of their employees. It is true that the president of the Economics Section later on disagreed with these criticisms of the employers' method of choice. Mr. Hichens considered that employers exercised an extraordinary amount of care in choosing workers, both for higher and for lower positions. Indeed, they showed some advance upon the methods hitherto adopted by educationists. Instead of setting examination papers in which candidates were asked to name the kings of Israel, they asked questions and used trial tasks which had a definite bearing upon the trade process concerned.

In face of this slight disagreement among the economists, the psychologists replied that, even if the employers' methods were superior to the old-fashioned methods of the educationists, they were still highly unscientific and quite unstandardised. As an instance of the work possible and necessary in this direction, Dr. C. S. Myers (director of the Cambridge Psychological Laboratories) described the work of the new

[1] Discussion at a joint meeting of the Sections of Psychology, Education and Economics of the British Association at Edinburgh on September 8

National Institute of Industrial Psychology in London. Here attempts were being made at the request of large firms not only to improve the psychological conditions in their industries, but also to send scientifically trained psychologists to test applicants for particular kinds of work. Other psychologists, who spoke later, emphasised the value of the vocational testing already carried out in America, and dwelt especially upon the success of recent tests for general ability or intelligence.

There seemed a general feeling, announced particularly by the educationists, that the process of vocational guidance and testing should begin while the child was still at school; and it was even suggested that the general kind of education imparted at school should be very largely determined by the results of such tests.

This, indeed, was the position taken up in the opening speech by Dr. C. W. Kimmins (Chief Inspector of the Education Department of the London County Council). London, he claimed, offered the finest field for psychological research in the whole world. Here, under one authority, were accumulated 800,000 children and 20,000 teachers. He pointed out that the London County Council had, just before the outbreak of the war, added to the officers of the education department a psychologist, whose business it was to investigate both individual cases and general problems in the schools; and he described in detail certain aspects of the psychological work under the Council, work (he added) that only the recent demand for economy had prevented from rapid expansion. Since psychology had taken an important and an official part in investigations among school children, there had been, in London at any rate, large changes. In days gone by the children sent to special schools for the mentally deficient were often merely backward; and, thus stigmatised as mentally defective, their vocational future was often seriously prejudiced. But it was now possible by means of psychological tests to ascertain at the outset whether a child was genuinely and innately defective in native ability, or whether he was merely retarded through accidental causes in his educational attainments alone. His own experience of special schools now was that the children sent to them at the present day were really mentally deficient; and here, in schools of this type, the elder boys receive special industrial training suited to their capacities and future prospects. At the other end of the scale intelligence tests were now also being used in connection with the transference of brighter children to the secondary schools. Certain children, he said, might, up to a certain stage, do well in routine school work, and even pass their scholarship examinations, and yet it might prove that they had not sufficient inborn intelligence to profit by the higher instruction.

Dr. Kimmins, however, urged not merely the employment of the better known tests of intelligence, but also the elaboration of tests specifically devised for different occupations. In this reference he stated that some time ago he had made an investigation into the after-employment of children in the London district. He described the state of affairs that he found as tragic. In their first appointments an enormous proportion of the children gained unsuitable jobs; when they found themselves unsuitable they threw them up and drifted from one position to another. In many cases he found that boys of the greatest promise had eventually become mere van boys. And, generally, he concluded, although we spend an enormous amount of money upon education, we fail to give sufficient attention to the marketing of our products. He, therefore, advocated the adoption of a system by which the child, upon leaving school, would receive a carefully drawn up statement, based upon psychological tests and prolonged observation, showing the line of employment for which he or she was best fitted. If this were done, he argued, the number of misfits would be much fewer than that observable to-day.

Mr. D. Kennedy Fraser (lecturer in education at the University of Edinburgh) spoke upon similar lines. He described from personal experience the use of intelligence tests in America. The result of these had been to show that an appreciable proportion of the population, something like one in forty, did not even during adult life attain a mental level beyond that of the average ten-year-old child. He strongly urged the execution of similar researches in this country. He concluded that, as a result of the newer discoveries made by the application of psychological methods to school children, the use of intelligence tests would eliminate—and was, indeed, the only possible way to eliminate—an enormous waste of time and effort on the part of teachers. Thus vocational testing and vocational training were now needed as an essential part of a system of general education.

Mr. Frank Watts, formerly lecturer on psychology in the University of Manchester, agreed with the foregoing speakers upon the importance of vocational testing, but he emphasised the fact that the tests were as yet still somewhat imperfect. The problem was usually stated too simply. It was depicted purely as a question of fitting pegs, round or square, into holes of an appropriate shape. He pointed out that the pegs were plastic and malleable, and the holes were constantly changing their shape; and both, as a rule, were neither absolutely square nor absolutely round. Further psychological investigation was, therefore, needed not only into the capabilities of the applicant, but also upon the requirements of the different kinds of job for which he might apply. Just as Sir William Beveridge had urged that firms should take a more intelligent interest in testing and training, so Mr. Watts urged that educationists must bring the schools into more vital contact with the industrial firms. One of the chief difficulties was that not only did the employer know nothing about the applicant, but the applicant when he left school knew nothing about industry.

This latter point was also emphasised in the speech of Dr. Myers, who made the very valuable suggestion that the kinematograph should be used to show the responsibilities, the prospects, the advantages, and the dangers of various occupations. Dr. Myers insisted that the choice of the occupation must be made by the individual himself; but the boy needed advice; and, helpful as they might be, neither teachers nor parents were entirely adequate to supply that advice because they themselves were without detailed knowledge of industrial requirements. Expert advice, therefore, was essential. Here once more was evident the need for a national institute of vocational psychology, though, even in the work of such an institute, the co-operation of the teacher and of the education authority still remained indispensable.

Miss L. Grier (principal-elect of Lady Margaret Hall, Oxford) was one of the few speakers who explicitly urged the importance of direct vocational training in addition to general vocational testing. It was apparently her view that, after we had discovered what the boy was suitable for, we should attempt to teach him and train him somewhat more specifically upon those lines. In giving this training, the question as between the factory and the school, she believed, was no longer confused by the old distinction between useful and useless knowledge. The idea that knowledge that was useful ceased to be educational was now exploded. The special institu-

tions that existed for giving training in particular subjects should now be able to supply excellent apparatus and specialised teachers for the purpose. Unfortunately, however, too often these institutions were crippled in their finances.

Prof. Reid, of Aberdeen, urged that the responsibility of training was at present thrown too exclusively upon the schools. Speakers had argued for industrialising education. He wished to argue for educationalising industry. And he thought that a hopeful change in this direction might be anticipated if the spirit of the older and smaller industries could be got into the big industrial concerns to-day. Other speeches, following somewhat upon these lines, seemed to indicate that the general opinion of the three united sections had reached this interesting, and, on the surface, somewhat paradoxical, conclusion: at present the industries left training to the school, and kept vocational selection to themselves; it was urged the industries should take upon themselves more and more of the responsibilities of training, and the schools should take on more and more of the work of the testing and selecting with a view to ultimate vocational guidance. But it seemed universally agreed that, whether in the matter of training or in that of selection, neither school nor industry could shift the responsibilities entirely on to the shoulders of the other.

Mechanical Engineering Education in Bengal.

SOME months ago a committee was appointed by the Government of Bengal to investigate the training of mechanical engineers in the Province, with special reference to the improvement of the education of apprentices in the State railway workshops at Kancharapara. The committee consists of Sir Rajendra Nath Mookerjee, Mr. A. T. Weston (Director of Industries), Mr. B. Heaton (principal, Bengal Engineering College), Prof. R. Wolfenden (professor of mechanical engineering, Bengal Engineering College), Mr. W. H. Everett (Director of Technical Education, Bengal), Mr. A. Cochran, Mr. H. Spalding, Mr. S. A. Skinner, Mr. Miller King, Mr. H. S. Strachey (representing the railway workshops and various well-known engineering firms in Calcutta), and Dutt Subrawardy, of the Bengal Legislative Council.

This committee is to be known as the "Board of Control for Apprenticeship Training in Bengal." It has had several meetings and has drawn up a scheme of apprenticeship training which, it is hoped, will greatly improve mechanical engineering education in Bengal. The scheme, which will be put into operation at Kancharapara immediately, consists of an admission examination (similar to the graduate examination of the Institution of Mechanical Engineers), followed by four years' training in workshops with compulsory attendance at a technical school to be built at Kancharapara. All the apprentices will live in barracks to be provided by the railway. It is hoped that by the end of the four years of training the brighter students will have reached such a standard of proficiency in mechanical engineering subjects as will enable them to proceed to a two years' course in the mechanical engineering department of the Bengal Engineering College. Those who are not sufficiently well qualified to be admitted to the college will remain at the works for a further two years of training. The course will, therefore, in all cases be a six years' course. The scheme, at present, will be compulsory only in the workshops of the East Bengal Railway at Kancharapara, but it is hoped that other State workshops—such as the ordnance factories and the large engineering firms in Calcutta—will join in the scheme.

The new Board of Control is also supervising the courses and examinations in mechanical engineering at the Bengal Engineering College. These courses have to provide, at present, for students admitted directly to the college after having passed the matriculation, or the intermediate science examinations of Calcutta University. They comprise (*a*) a three years' course at the college, together with three years' practical training in approved workshops, leading to a college diploma; and (*b*) a four years' course at the college followed by two years' practical training in workshops leading to the associateship of the college. Course (*b*) is for the exceptionally good men who, in the opinion of the examiners and of the professor of mechanical engineering, would profit by a year of more advanced training.

The courses are arranged to suit the conditions prevailing in India, and will include training in modern workshop methods and measurements, and in workshop management and accounts. It is hoped that these courses will succeed in producing a regular supply of thoroughly trained mechanical engineers for service in the Province.

University and Educational Intelligence.

EDINBURGH.—There comes into operation this year the new Science Ordinance, under which a student may study either for a pass or for an honours B.Sc. degree. Four years is the minimum time in which either degree may be completed. The main difference between the two classes of degree is that a student aiming at the honours degree in any science devotes in general the third and fourth years to a specialised study of the subject he is professing, cognate sciences being studied up to a somewhat lower standard. In the pass degree several branches of science are carried forward simultaneously to an intermediate standard. With the exception of the first year chemistry the lectures and laboratory work are now being conducted in the new King's Buildings on the southern margin of greater Edinburgh. Next year all the work will be transferred there.

The University Court has approved generally of a draft Ordinance founding an independent professorship in the department of natural philosophy, to be called the Tait chair of natural philosophy.

The following new courses have been instituted:—(1) A course in Indian geology for forestry students who have been selected as probationers for the Indian Forest Service, and (2) two half courses in economic geology, the first to deal with ore deposits.

In terms of an Act of Parliament recently passed the income of the John Newland Endowment (capital 22,500*l.*) will in future be applied in bursaries, the award to be determined on the results of the University examination for entrance bursaries.

Negotiations have been completed for the purchase of about ten acres of ground for the extension of the University athletic field.

MANCHESTER.—Prof. F. E. Weiss has been appointed Pro-Vice-Chancellor.

The resignation of Mr. P. A. Cooper, assistant lecturer in physics, is announced.

Mr. C. G. Core and Miss Lucy Higginbotham have been re-appointed Schunk research assistants.

PROF. W. A. BONE will deliver a lecture on "The late W. A. Haward's Experiments upon the Combustion of Hydrogen-Carbon Monoxide at High Pressures" before the Royal College of Science Chemical Society on Friday, November 11. The lecture is intended as a memorial to Mr. Haward, who lost his life in December last through an accident while carrying on research on the subject of the lecture.

THE MARQUESS OF CREWE will preside at the annual dinner of the Old Students' Associations of the Imperial College of Science and Technology, London, to be held on Thursday, November 24, at the Trocadero Restaurant, London, W.1. He will be supported by distinguished guests, the governors, and by past and present professors and staff of the college and its constituent colleges.

THE usual winter courses of the Ecole d'Anthropologie will begin at Paris on November 4. The ten professors all continue their teaching on the branches of anthropology with which they are concerned, and their number has been augmented by the appointment of M. Paul Boncour as professor of criminal anthropology. Conferences will be held by M. G. Courty on the petroglyphs of the region round Paris, by M. Dubreuil-Chambardel on the geography and anthropological history of the basin of the Loire, and by M. Saintyves on the origin of *contes*, and the *contes* of Perrault considered in the light of anthropology and ethnography.

THAT Battersea Polytechnic, like most other institutions for higher education, is hampered by lack of accommodation is apparent from a perusal of the Principal's report for the session 1920–21. The entries for the day courses are shown for a number of past sessions, of which it is sufficient for purposes of comparison to take the figures for the session 1913–14. An increase of, roughly, 30 per cent. is shown by the entries for the 1920–21 session, although there are now very few in training who may be regarded as students whose training was interrupted by war service. Unfortunately, a similar comparison of numbers of evening students is not possible. The figures for 1914–15 are, however, given, and an equally striking increase, in this case of nearly 55 per cent., is shown. These numbers are an ample confirmation of the Principal's plea for increased accommodation. In spite of the strain which this increase of numbers has placed on the teaching staff, a certain amount of research has been undertaken by the Principal and his colleagues, and, in addition, a few research students have been at work in the chemical and engineering departments.

THE Rhodes Trust has issued a statement for the academic year 1020–21 dealing with the scholarships it administers. From the pamphlet it appears that no less than 277 Rhodes scholars were in residence during that period, 129 from the United States, and 148 from the British Empire; 120 took up their scholarship for the first time during the year. The figures giving the distribution according to subjects show that law, with 91 scholars, claimed the greatest number, while natural science, in which medicine is included, came next with 62; mathematics had six Rhodes scholars, forestry three, agriculture and geography two each, and one took anthropology. The value of the scholarship has now been increased by 50*l.* per annum, but the Trust warns prospective scholars that even thus the emoluments will not ordinarily cover the expenses of a full year. Appointments will be made to the 1923 scholarships during the course of next year, and further information can be obtained from the Secretary, Seymour House, Waterloo Place, S.W.1.

Calendar of Scientific Pioneers.

November 3, 1643. Habakkuk Guldin died.—A convert to the Roman Catholic faith, Guldin, or Guldinus, held the chairs of mathematics in the Jesuit colleges at Rome and Gratz. His "Centrobarytica," 1635–42, contained his well-known theorems.

November 3, 1832. Sir John Leslie died.—The successor of Playfair in the chairs of mathematics and natural philosophy at Edinburgh, Leslie made researches in radiation, photometry and hygroscopy in connection with which he devised the differential thermometer. He was the first to freeze water by rapid evaporation in a vacuum.

November 4, 1698. Erasme Bartholin died.—Bartholin, or Berthelsen, a member of a Danish scientific family, was first professor of mathematics, and then professor of medicine at Copenhagen. He is remembered for his discovery in 1669 of the double refraction in Iceland spar.

November 5, 1879. James Clerk Maxwell died.—Born in Edinburgh in 1831, Maxwell was educated at Edinburgh and Cambridge, and in 1854 was Smith's prizeman. He later held the chairs of natural philosophy at Marischal College, Aberdeen, and King's College, London, and in 1871 became the first Cavendish professor of experimental physics at Cambridge, where he died. His principal investigations referred to the kinetic theory of gases, the perception of colour, the theory of the electromagnetic field, and the electromagnetic theory of light. His great treatise on electricity and magnetism, called the Principia of the nineteenth century, appeared in 1873, and in 1879 he published the "Electrical Researches of the Hon. Henry Cavendish." Maxwell was the successor of Faraday, from whom he drew much inspiration, and his electrical work has revolutionised the whole aspect of science.

November 6, 1777. Bernard de Jussieu died.—The brother of Antoine de Jussieu (1686–1758), Bernard de Jussieu also was celebrated as a botanist, and for many years was connected with the Jardin du Roi. He was the first to prove that fresh-water polypi are animals and not plants.

November 6, 1822. Claude Louis Berthollet died.—The contemporary of Lavoisier, de Morveau, and Chaptal, Berthollet contributed greatly to the advance of chemistry, and among his discoveries was that of the bleaching power of chlorine. His "Essai de Statique Chimique," the first attempt to deal with chemical physics, apeared in 1803.

November 7, 1817. Jean André Deluc died.—A native of Geneva, Deluc engaged in business for some years, but in 1773 came to England and was made reader to Queen Charlotte. He made valuable observations on meteorology, and to him is due the scientific use of the word geology.

November 7, 1872. Rudolph Friedrich Alfred Clebsch died.—Professor of mathematics at Karlsrühe, Giessen, and Göttingen, Clebsch wrote on elasticity, Abelian functions, and on binary algebraical forms.

November 9, 1871. Adolph Strecker died.—Trained under Liebig at Giessen, Strecker was afterwards professor at Christiania, Tübingen, and Wurzburg, and was known for his researches in organic chemistry.

November 9, 1896. Johan August Hugo Gylden died.—A distinguished Swedish astronomer, Gylden was trained by Hansen, served under Struve at Pulkowa, and in 1871 became director of the observatory at Stockholm. The theory of the motion of the planets and comets, stellar parallax, proper motions, cosmogony, and photometry are among the subjects dealt with in his numerous memoirs. E. C. S.

Societies and Academies.

LONDON.

Association of Economic Biologists, October 14.—Sir David Prain, president, in the chair.—Dr. W. **Brown**: The physiology of the infection process. The lecturer gave an account of recent work carried out in the Imperial College of Science on the physiology of parasitism, dealing chiefly with the fungus *Botrytis cinerea*. Evidence was brought forward showing that the actual penetration of the host-tissue took place by mechanical means. The most careful examination, both by chemical and cytological methods, failed to show evidence of a cutin-dissolving enzyme. The mechanical theory of penetration was further supported by the fact that fungi could penetrate membranes, such as gold-leaf, paraffin-wax, etc., on which they could not possibly exert any chemical action whatsoever. The well-known "action in advance" subsequent to penetration was shown to be due to a toxic enzyme, the properties of which had been studied in detail. Previous to penetration the fungus exerted no action on the host. On the other hand, a passive exosmosis of substances took place from the host into the infection drop, this leading in some cases to stimulation, in others to inhibition, of fungal germination. The question of the existence of tropic stimuli as a factor in infection was discussed, and attention was directed to the necessity of investigating the nutritional requirements of particular fungi, in connection with which numerous problems had arisen in recent work.

Zoological Society, October 18.—Sir S. F. Harmer, vice-president, in the chair.—Prof. G. Elliot **Smith**: The habits of Tarsius.—S. **Hirst**: Some new parasitic mites.—Prof. J. P. **McMurrich**: Note on the systematic position and distribution of the Actinian, *Sagartia luciae*.

MANCHESTER.

Literary and Philosophical Society, October 14.—Mr. T. A. Coward, president, in the chair.—Dr. I. **Langmuir**: Molecular structure. The modern conception of the atom is that of a nucleus surrounded by electrons, and all the chemical and physical properties of the atom are due, in a large measure, to the number of these electrons and their arrangement around the nucleus. The author indicated three postulates, and explained in certain cases how these postulates accorded with the simple and well-known properties of the atoms considered. He was able to show wherein lay the fundamental difference between organic chemical compounds and inorganic compounds; and he explained how the electrical conductivity of certain substances in the molten state or in solution could be accounted for and why some elements are gaseous and others solid under ordinary conditions.

October 18.—Mr. T. A. Coward, president, in the chair.—Prof. T. H. **Pear**: The visualisation of numbers in space: some comments upon Galton's theory of number-forms. The ability to picture numbers mentally during calculation is not infrequently combined with a tendency to see them arranged in a definite pattern, each number occupying a fixed position relative to the subject's line of sight. Such number-forms are by no means rare; 7 per cent. of a large number of university students were found to possess them. The spatial relations of the numbers are so definite and fixed that tri-dimensional wire models representing them exactly can be made. Two such models, made by members of the society, were exhibited. Most possessors of number-forms do not regard their gift as unusual, and are sometimes surprised to discover that calculation is possible without them. The lecturer discussed a number of aspects of the subject, of which Sir Francis Galton's original description in the "Inquiries into Human Faculty" can now be supplemented or corrected. While Galton believed that number-forms were hereditary, the lecturer held that Galton's evidence was inadequate, and he produced evidence to show that environmental factors could produce resemblances between number-forms amongst unrelated persons as great as, or greater than, those found by Galton to occur in the same family. Moreover, the common appearance in number-forms of the clock-face, the statistical frequency with which the turns occur at 10 and 12, and the occasional representation of the negative values support the view that they are acquired.

PARIS.

Academy of Sciences, October 17.—M. Georges Lemoine in the chair.—A. **Blondel**: A vectorial equation, in complex notation, of the alternator with two reactions. Its applications.—C. **Camichel**: Hydraulic states of flow. An experimental study of the conditions of steady and turbulent flow of water in tubes.—C. **Le Morvan**: Photographic and systematic map of the moon. Remarks on the second part of the map of the moon, comprising the surface visible at the phases between opposition and new moon.—M. **Baudouin**: The material representation on stone of the constellation of the Great Bear, belonging to the polished stone period. A detailed account of five undoubted cases representative of the constellation Ursa Major on bones of the neolithic period.—J. **Guillaume**: Observations of the sun made at the Observatory of Lyons during the second quarter of 1921. Observations were possible on 88 days during the quarter: the results are given in tables showing the number of sunspots, their distribution in latitude, and the distribution of the faculæ in latitude.—M. **Brillouin**: Bohr's atom. The Lagrange circum-nuclear function.—K. **Ogura**: The curvature of light rays in the field of gravitation.—C. E. **Brazier**: The resistance of the air to the movement of spheres, and the rate of ascent of pilot balloons. From the experimental data of Cave and Dines, Rouch, and La Porte, the values of K, the coefficient of resistance, are calculated corresponding to increasing values of N (Reynolds's number).—A. **Dauvillier**: Contribution to the study of the electronic structure of the heavy atoms and their spectral lines.—M. **Dejean**: The demagnetising field of cylindrical bars of mild steel. Curves are given showing the relations between the intensity of magnetisation and strength of field for a series of bars of the same steel, varying in length from 5 mm. to 1200 mm. The demagnetising influence of the poles is illustrated by a second series of curves derived from the first set.—G. **Claude**: The manufacture of hydrogen by the partial liquefaction of water gas. Experiments in the preparation of hydrogen suitable for ammonia synthesis from water gas, commenced in 1908, were abandoned on account of the difficulties encountered. The work has been taken up again and the difficulties surmounted. The gas is allowed to do external work on expansion, and the lubrication troubles caused by the low temperatures were prevented by the addition of 5 per cent. of nitrogen to the hydrogen. A diagram of the apparatus is given. A plant is now working at Montereau treating 500 cb.m. of water gas per hour, and giving 230 cb.m. of hydrogen containing 1·5 per cent. of carbon monoxide. The energy required can be cheaply furnished by the utilisation of one quarter of the liquefied

carbon monoxide in a gas engine.—H. **Copaux**: A rapid method for the estimation of phosphoric acid.—A. **Mailhe**: Petrol prepared from rape oil. Rape oil was treated at 550–650° C. with a copper–aluminium catalyst, and the lighter liquid fractions hydrogenated over nickel. The petrol contained large proportions of aromatic and naphthenic hydrocarbons.—P. **Bugnon**: The theory of syncotylia and the case of *Streptopus amplexifolius*. The notion of the phyllode applied to the interpretation of the cotyledon of the Monocotyledons.—L. **Léger** and S. **Stankovitch**: Artificial impregnation and development of *Aspro asper*.—L. **Blaringhem**: The production of the "marbled varieties" of the bean, *Vicia Faba*. An account of the results of experiments in crossing *Vicia Faba*, variety *pliniana*, with the variety *equina*.—R. **Courrier**: The determinism of the secondary sexual characters in the Arthropods. In agreement with previous observations on vertebrates, the seminal elements do not determine the secondary sexual characters in Arthropods. These are probably determined by a hormone produced by an organ physiologically independent of the seminal gland.—Mlle. M. **Gauthier**: Coccidia of *Cottus gobio*.—L. **Fournier** and L. **Guénot**: The treatment of syphilis by bismuth. An account of the treatment of 110 cases of syphilis by tartro-bismuthate of potassium and sodium: the favourable results fully confirm those of R. Sazerac and Levaditi, and prove the powerful therapeutic effects of bismuth against syphilis in various forms.

BRUSSELS.

Royal Academy of Belgium, July 2.—M. Cesàro in the chair.—G. **Cesàro**: An elementary demonstration of the form of the caustic by reflection, and of the formula giving the refractive index of a prism as a function of the minimum angle of deviation.—G. **Cesàro**: The form of the crystals deposited by a thin layer of crystal-forming liquid on a plain sheet of glass.—C. **Servais**: Orthological reciprocal tetrahedra.—J. **Neuberg**: The orthogonal projection of a tetrahedron on a plane and on a surface of the fourth order.—F. **Swarts**: Some fatty fluorides.—A. **de Hemptinne**: Reduction of metallic oxides by the silent electric discharge (fourth communication).—E. **van Aubel**: A relation between the absolute melting points, boiling points, and critical temperatures of bodies.—E. **Henriot** and R. **Crombes**: Variation of the refractive index with temperature. Numerical comparison of the different formulæ proposed.

August 6.—G. Cesàro in the chair.—C. **Servais**: The quadrics of revolution.—A. **Demoulin**: Encircled surfaces.—V. **Willem**: Synchronism of the respiratory movements and the cardiac pulsations of fishes.—H. **Rouche**: Parafluorometanitrobenzoic acid.

October 8.—G. Cesàro in the chair.—P. **Stroobant**: Observations of Saturn made in 1921 at the time of disappearance of the ring.—J. **Verschaffelt**: The graphical construction of capillary menisci.—J. **Verschaffelt**: The determination, by graphical construction, of the capillary rise of a liquid between two coaxial cylinders.—J. **Neuberg**: A problem on articulated quadrilaterals.—A. **de Hemptinne**: The reduction of metallic oxides by the silent electric discharge.—L. **Godeaux**: A linear congruence of skew cubics.—M. **Keelhoff**: Airy's formula.

WASHINGTON, D.C.

National Academy of Sciences, Proceedings, vol. 6, No. 10. October, 1920.—A survey of research problems in geophysics prepared by chairmen of sections of the American Geophysical Union. This detailed research survey has the following major subdivisions: W. **Bowie**: Present status of geodesy and some of the problems of this branch of geophysics; H. F. **Reid**: The problems of seismology; C. F. **Marvin**: The status and problems of meteorology; L. A. **Bauer**: Some of the chief problems in terrestrial magnetism and electricity; G. W. **Littlehales**: The problems and functions of the Section of Physical Oceanography of the American Geophysical Union; H. S. **Washington**: The problems of volcanology; R. B. **Sosman**: An outline of geophysical-chemical problems.—W. D. **Harkins**: The ionisation of strong electrolytes. Discussion of the various meanings attached to the word "ionise."—A. G. **Webster**: A condition for Helmholtz's equation similar to Lamé's.—W. **Duane**, H. **Fricke**, and W. **Stenström**: The absorption of X-rays by chemical elements of high atomic numbers. The critical absorption wave-lengths of the K series of most of the available chemical elements from tungsten to uranium were measured. The values of the wave-lengths are uniformly larger than those obtained by photographic methods, by an amount between 1 and 2 per cent.—E. H. **Hall**: The Thomson effect and thermal conduction in metals. A continuation of previous papers on thermal conduction. Data are given for eighteen metals, and compared with the theory.—J. **Lipka**: Motion on a surface for any positional field of force. The complete geometric characteristic properties of the system of trajectories are determined.

Books Received.

Geography for Senior Classes. By E. Marsden and T. Alford Smith. Pp. x+521+14 coloured maps. (London: Macmillan and Co., Ltd.) 7*s*. 6*d*.

Islands Far Away: Fijian Pictures with Pen and Brush. By Agnes G. King. Second edition. Pp. xxxii+256. (London: Sifton, Praed and Co., Ltd.) 18*s*. net.

Catalogue of Scientific Papers. Compiled by the Royal Society of London. Fourth series (1884–1900). Vol. 17, Marc–P. Pp. v+1053. (Cambridge: At the University Press.) 9*l*. net.

Relativity and Gravitation. Edited by J. Malcolm Bird. Pp. xiv+345. (London: Methuen and Co., Ltd.) 8*s*. 6*d*. net.

Atomic Theories. By F. H. Loring. Pp. ix+218. (London: Methuen and Co., Ltd.) 12*s*. 6*d*. net.

Guide Pratique de Sylviculture. By Dr. F. Fankhauser. Troisième édition française, by M. Petitmermet. Pp. 348. (Lausanne, Genève, and Paris: Payot et Cie.)

Bartholomew's General Map of Europe, showing Boundaries of States according to Treaties. 35 in. by 23 in. (Edinburgh: J. Bartholomew and Son, Ltd.) 1*s*. net.

Le Parasitisme et la Symbiose. By Prof. M. Caullery. (Encyclopédie scientifique: Bibliothèque de Biologie générale.) Pp. xiii+400+xii. (Paris: G. Doin.) 14 francs net.

Plane Geometry for Schools. By T. A. Beckett and F. E. Robinson. Part 1. Pp. viii+239+v. (London: Rivingtons.) 5*s*.

Hellenism and Christianity. By E. Bevan. Pp. 275. (London: G. Allen and Unwin, Ltd.) 12*s*. 6*d*. net.

Department of Scientific and Industrial Research. The Geological Survey of Great Britain and the Museum of Practical Geology: Report of the Geological Survey Board with the Report of the Director for the Year 1920. Pp. 25. (London: H.M. Stationery Office.) 1*s*. net.

The Psychology of Society. By Morris Ginsberg. Pp. xvi+174. (London: Methuen and Co., Ltd.) 5s. net.

Ministère de l'Agriculture. Direction Générale des Eaux et Forêts. (2e Partie): Service des Grandes Forces Hydrauliques (Région du Sud-Ouest). Résultats Obtenus pour le Bassin de l'Adour pendant les Années 1917 et 1918: Tome 7, Fascicule A. Pp. 39+Charts 2–51. 2e Partie: Eaux et Génie Rural. Service des Grandes Forces Hydrauliques (Région du Sud-Est). Annexe 1 du Tome 9: Nivellements. Planches 162–191. Annexe 2 du Tome 9: Cartes. Charts 21–28. 2e Partie: Eaux et Améliorations Agricoles. Service des Grandes Forces Hydrauliques (Région du Sud-Est): Compte rendu et Résultats des Études et Travaux au 31 Décembre, 1917. Tome 9. Pp. 491. (Paris: Ministère de l'Agriculture.)

Exceptional Children and Public School Policy: Including a Mental Survey of the New Haven Elementary Schools. By Prof. A. Gesell. Pp. 66. (New Haven: Yale University Press; London: Oxford University Press.) 4s. 6d. net.

Laboratory Manual in General Microbiology. Prepared by the Laboratory of Bacteriology and Hygiene, Michigan Agricultural College. Second edition. Pp. xxii+472. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 21s. net.

General Physics and its Application to Industry and Everyday Life. By Prof. E. S. Ferry. Pp. xvi+732. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 24s. net.

Handbook of Meteorology: A Manual for Co-operative Observers and Students. By J. W. Redway. Pp. v+294. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 24s. net.

Organic Dependence and Disease: Their Origin and Significance. By Dr. J. M. Clarke. Pp. 113. (New Haven: Yale University Press; London: Oxford University Press.) 12s. 6d. net.

A Treatise on the Transformation of the Intestinal Flora, with special reference to the Implantation of Bacillus Acidophilus. From the Sheffield Laboratory of Bacteriology, Yale University. By Prof. L. F. Rettger and H. A. Cheplin. Pp. vii+135+8 plates. (New Haven: Yale University Press; London: Oxford University Press.) 12s. 6d. net.

Les Combustibles liquides et leurs Applications. Par le Syndicat d'Applications Industrielles des Combustibles liquides. Pp. iii+621. (Paris: Gauthier-Villars et Cie.)

Examples in Optics. Compiled by Dr. T. J. I'a Bromwich. Pp. 16. (Cambridge: Bowes and Bowes.) 2s. net.

University of Calcutta: Anthropological Papers, No. 6. The First Outlines of a Systematic Anthropology of Asia, with Tables of Stature, Cephalic Index, and Nasal Index of Living Subjects. By Prof. V. Giuffrida-Ruggeri. Translated from the Italian by Haranchandra Chakladar. Revised by the author with additions. (Reprinted from the Journal of the Department of Letters, vol. 5). Pp. 110. (Calcutta: University Press.)

Sir Jagadish Chander Bose: His Life, Discoveries, and Writings. Pp. vii+40+248. (Madras: G. A. Natesan and Co.) 3 rupees.

The Induction Motor and other Alternating Current Motors: Their Theory and Principles of Design. By B. A. Behrend. Second edition, revised and enlarged. Pp. xxiii+272. (New York and London: McGraw-Hill Book Co., Inc.) 24s. net.

Alchemy: Its Science and Romance. By the Rt. Rev. J. E. Mercer. Pp. x+245. (London: S.P.C.K.) 9s. net.

Handbuch der Holzkonservierung. Edited by Ernst Troschel. Pp. xi+540. (Berlin: J. Springer.) In Germany, 18 marks; in England, 54 marks.

The Physical Society of London and the Optical Society. A Discussion on "The Making of Reflecting Surfaces," held on November 26, 1920, at the Imperial College of Science and Technology, South Kensington, S.W.7. Pp. iii+44. (London: The Optical Society.) 5s.

Found Wanting: A Labour Verdict on Prohibition. By C. H. Sitch and J. E. Davison. Pp. 15. (London: Harrison, Jehring and Co., Ltd.) 6d.

Botanical Memoirs, No. 10: The Somatic Organization of the Phæophyceæ. By A. H. Church. Pp. 110. (New York and London: Oxford University Press.) 5s. net.

Absolute Measurements in Electricity and Magnetism. By Prof. A. Gray. Second edition, rewritten and extended. Pp. xix+837. (London: Macmillan and Co., Ltd.) 42s. net.

Radioactivity and Radioactive Substances. By Dr. J. Chadwick. (Pitman's Technical Primer Series.) Pp. xii+111. (London: Sir Isaac Pitman and Sons, Ltd.) 2s. 6d. net.

Illustrations of the Flowering Plants and Ferns of the Falkland Islands. By Mrs. E. F. Vallentin. With Descriptions by Mrs. E. M. Cotton. Pp. xii+64 plates and text+2. (London: Lovell Reeve and Co., Ltd.) 84s. net.

Technique of the Teat and Capillary Glass Tube: Being a Handbook for the Medical Research Laboratory and the Research Ward. By Sir Almroth E. Wright, with the collaboration of L. Colebrook. Second edition. Pp. xxvi+384+3 plates. (London: Constable and Co., Ltd.) 42s. net.

Diary of Societies.

THURSDAY, NOVEMBER 3.

ROYAL SOCIETY, at 4.30.—Prof. T. R. Merton: The Spectra of Lead Isotopes.—G. I. Taylor: Experiments with Rotating Fluids.—Prof. L. Bairstow, Miss B. M. Cave, and Miss E. D. Lang: The Two-dimensional Slow Motion of Viscous Fluids.—Prof. H. C. H. Carpenter and Constance Elam: The Production of Single Crystals of Aluminium and their Tensile Properties.—Prof. C. V. Raman and B. Ray: The Transmission Colours of Sulphur Suspensions.—Prof. E. F. Burton and Miss E. Bishop: The Law of Distribution of Particles in Colloidal Solution.

LINNEAN SOCIETY, at 5.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Sqdn.-Ldr. R. M. Hill: Manœuvres of Getting Off and Landing.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), at 5.30.—Dr. H. Joseph: A Retrospect of a Quarter of a Century of Seaside Practice.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—J. S. Highfield: Inaugural Address.

CHEMICAL SOCIETY, at 8.—Informal Meeting.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—Dr. G. Cranstoun: Cystic Adenoma of the Uterus.—Dr. R. L. MacKenzie Wallis: Glycosuria in Pregnancy.

FRIDAY, NOVEMBER 4.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 4.45.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 5.—Col. H. G. Lyons, Prof. C. V. Boys, Col. E. H. Grove-Hills, and Col. Sir G. P. Lenox-Conyngham: The Eötvös Gravity Balance.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Dr. H. S. Hele-Shaw: Power Transmission by Oil (Thomas Hawksley Lecture).

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—H. E. G. Boyle: Report on his visit as Official Representative of the Section to the first meeting of the Canadian Society of Anæsthetists at Niagara, and to the meeting of the American Society of Anæsthetists at Boston in June last.

MONDAY, NOVEMBER 7.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

SOCIETY OF ENGINEERS, INC. (at Geological Society), at 5.30.—C. H. Naylor: Extraction Turbines.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—J. S. Highfield and others: Discussion: How Best to Speed Up Electrical Progress.

ARISTOTELIAN SOCIETY (at 21 Gower Street), at 8.—Prof. J. H. Leuba: Intuition in Experience and in Philosophy.

SOCIETY OF CHEMICAL INDUSTRY (at Chemical Society), at 8.—N. E. Rambush: Comparison between Laboratory Fuel Tests and Practical Working Results of the Producer Gas Process.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—M. W. Hilton-Simpson: The Aurco Massif, Algeria.
ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.30.—P. Waterhouse: Inaugural Address.

TUESDAY, NOVEMBER 8.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. Moon: First FitzPatrick Lecture.
ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—E. P. Chance: The Laying-habits of the Cuckoo (*Cuculus canorus*) and the Life of the Young Cuckoo.—Dr. W. Rae Sherriffs: Evolution within the Genus. Part I., *Dendronephthya* (*Spongodes*), with Descriptions of a Number of Species. Part II., Description of Species (Alcyonaria) taken by the "Siboga" Expedition.—Dr. C. F. Sonntag: The Comparative Anatomy of the Tongues of the Mammalia. V., Lemuroidea and Tarsioidea. VI., Summary and Classification of the Tongues of the Primates.—R. I. Pocock: The External Characters and Classification of the Mustelidæ.
ROYAL PHOTOGRAPHIC SOCIETY, at 7.—S. O. Rawling: Sepia Toning with Colloidal Sulphur.—W. L. Wilkinson: Scott Archer's and Hardwick's Wet Collodion Formula Revised.—Miss F. M. Hamer: The Optical and Photographic Properties of Some Isomeric Isocyanines.
QUEKETT MICROSCOPICAL CLUB, at 7.30.—F. Addey: *Pinus sylvestris*.
ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Capt. G. Crowden and Prof. G. Elliot Smith: The Mound Builders of Dunstable.

WEDNESDAY, NOVEMBER 9.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. L. D. Stamp and S. W. Wooldridge: The Igneous and Associated Rocks of Llanwrtyd (Brecon).—Dr. L. D. Stamp: The Base of the Devonian, with Special Reference to the Welsh Borderland.
ROYAL SOCIETY OF MEDICINE (Surgery: Subsection of Proctology), at 5.30.
INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Sectional Meeting), at 6.—Dr. G. W. O. Howe: Address.
INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 8.—Dr. L. Aitchison: Chromium Steels and Irons.
ROYAL SOCIETY OF ARTS, at 8.—D. R. Wilson: The Work of the Industrial Fatigue Research Board, and its applications to Industry.

THURSDAY, NOVEMBER 10.

ROYAL SOCIETY, at 4.30.—*Probable Papers*.—A. J. Wilmott: Experimental Researches on Vegetable Assimilation and Respiration. XIV., Assimilation by Submerged Water Plants in Dilute Solutions of Bicarbonates and of Acids, and Improved Bubble Counting Technique.—E. G. Young: The Coagulation of Protein by Sunlight.—E. G. Young: The Optical Rotatory Power of Crystalline Ovalbumin and Serum Albumin.—A. R. Ling and D. R. Nanji: The Longevity of Certain Species of Yeast.—F. Kidd, C. West, and G. E. Briggs: A Quantitative Analysis of the Growth of *Helianthus annuus*. Part I., The Respiration of the Plant and of its Parts throughout the Life Cycle.—G. S. Currey: The Colouring Matter of Red Roses.
ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. Moon: Second FitzPatrick Lecture.
CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—F. S. Marvin: The Teaching of History.
OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—Dr. A. Gleichen: The Path of Rays in Periscopes having an Inverting System comprising Two Separated Lenses.—Dr. J. W. French: The Interocular Distance.—T. Chaundy: Note on the Thin Astigmatic Lens.
INSTITUTE OF METALS (London Section) (at Royal School of Mines), at 8.—Prof. C. H. Desch: Plastic Flow in Metals.
INSTITUTION OF AUTOMOBILE ENGINEERS (at Olympia).—T. Thornycroft; N. Macmillan: Marine Motors.
ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Sir William Thorburn and Dr. W. Harris: Discussion: The Treatment of Persistent Pain due to Lesions of the Central and Peripheral Nervous System.

FRIDAY, NOVEMBER 11.

OIL AND COLOUR CHEMISTS' ASSOCIATION.
PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—Sir William Bragg: The Structure of Crystals of Organic Substances (Presidential Address).
ROYAL ASTRONOMICAL SOCIETY, at 5.
ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.
ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—Dr. W. S. Inman: The Relationship of Squint, Left-handedness, and Stammering.—Dr. C. F. Harford: The New Psychology and its Relation to Problems of Vision.

PUBLIC LECTURES.

(A number in brackets indicates the number of a lecture in a series.)

THURSDAY, NOVEMBER 3.

UNIVERSITY COLLEGE, at 5.—Prof. J. E. G. De Montmorency: Feudalism: The Background of the European System (1).
IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—W. Bateson: Recent Advances in Genetics (1).
CHADWICK PUBLIC LECTURE (at Royal Institute of British Architects), at 8.—Prof. P. Groom: Dry Rot of Wood and Sanitation.

FRIDAY, NOVEMBER 4.

UNIVERSITY COLLEGE, at 4.30.—Dr. J. C. Drummond: Nutrition (4). At 8.—Prof. G. Dawes Hicks: Our Knowledge of the Real World (1).

MONDAY, NOVEMBER 7.

KING'S COLLEGE, at 5.30.—Dr. W. R. Ormandy: Liquid Fuel Engines (2).
IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Dr. J. D. Falconer: The Wonders of Geology (Swiney Lectures) (1).

TUESDAY, NOVEMBER 8.

KING'S COLLEGE, at 5.30.—Prof. H. Wildon Carr: The Modern Scientific Revolution and its Meaning for Philosophy (5); The Principle of Relativity.—Dr. W. Brown: Psychology and Psychotherapy (4).—L. J. Hunt: Cascade Synchronous Motors and Generators (4).

WEDNESDAY, NOVEMBER 9.

KING'S COLLEGE, at 4.30.—Dr. C. Da Fano: Histology of the Nervous System (5). At 5.15.—Prof. R. R. Gates: Flora of the British Empire.
SCHOOL OF ORIENTAL STUDIES, at 5.—Rev. W. Sutton Page: Chaitanya and the Vaishnava Revival in the 16th Century.
IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Dr. J. D. Falconer: The Wonders of Geology (Swiney Lectures) (2).

THURSDAY, NOVEMBER 10.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 3.—W. Bateson: Recent Advances in Genetics (2).
UNIVERSITY COLLEGE, at 5.—Prof. J. E. G. De Montmorency: European Feudalism: Its Variation and Decay (2).
BIRKBECK COLLEGE, at 5.30.—Prof. F. Soddy: The Bearing of Physical Science on Economics (1).
KING'S COLLEGE, at 5.30.—H. W. Fitz-Simons: Bridge Construction (3).

FRIDAY, NOVEMBER 11.

UNIVERSITY COLLEGE, at 4.30.—Dr. J. C. Drummond: Nutrition (5). At 8.—Prof. G. Dawes Hicks: Our Knowledge of the Real World (2).
IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Dr. J. D. Falconer: The Wonders of Geology (Swiney Lectures) (3).

CONTENTS.

	PAGE
The Langley Flying Machine	297
The Impurity of Pure Substances. By Prof. F. G. Donnan, F.R.S.	298
The Birds of Australia. By W. E. C.	299
Climatic Factors in Agriculture. By B. A. Keen	300
Our Bookshelf	301
Letters to the Editor:—	
Metallic Coloration of Chrysalids. (*Illustrated.*)—A. Mallock, F.R.S.	302
Sex-manifestations and Motion in Molluscs.—Dr. J. H. Orton	303
The Presence of Perennial Mycelium in *Peronospora Schleideni*, Unger.—Paul A. Murphy	304
The Development of Optical Industries.—James Weir French; Mansell P. Swift; Prof. K. C. Browning	304
Qualities of Valency.—Dr. S. H. C. Briggs	306
Relation of the Hydrogen-ion Concentration of the Soil to Plant Distribution.—E. A. Fisher	306
Absorption of X-rays.—W. Ewart Williams and B. L. Worsnop	306
The Film-photophone.—W. S. Gripenberg; The Writer of the Note	307
Rainfall Records at Rothamsted.—W. D. Christmas	307
Edinburgh and the Rise of Oceanography. By Prof. W. A. Herdman, C.B.E., F.R.S.	308
Absorption Spectra. By Prof. E. C. C. Baly, C.B.E., F.R.S.	311
Artificial Production of Rain. By Dr. Harold Jeffreys	313
Obituary:—	
Prof. Ch. François-Franck	314
E. J. Bevan	314
Notes	315
Our Astronomical Column:—	
The November Meteors	319
Light of the Night Sky	319
Delineations of the Milky Way	319
The Danish Arctic Station. (*Illustrated.*) By Prof. A. C. Seward, F.R.S.	320
Psychological Tests for Vocational Guidance	321
Mechanical Engineering Education in Bengal	323
University and Educational Intelligence	323
Calendar of Scientific Pioneers	324
Societies and Academies	325
Books Received	326
Diary of Societies	327

THURSDAY, NOVEMBER 10, 1921.

Editorial and Publishing Offices:
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Applied Anthropology.

IN the course of the recent meeting of the British Association in Edinburgh one of the sessions of the Anthropological Section was devoted to the discussion of the ways and means by which the science of anthropology might be made of greater practical utility in the administration of the Empire, particularly in relation to the government of our subject and backward races. The question was raised by a communication from Sir Richard Temple, who, unfortunately, was not able to be present in person. He recalled the fact that in the course of his address as president of the section at the Birmingham meeting in 1913, and in a discussion which had been held later in the same meeting, he had brought this question before the Association and recapitulated the steps which had been taken afterwards by the Association and other bodies to bring this matter to the notice of the Government of that time and the public. This movement, which gained considerable support, was brought to an end by the outbreak of war. Once more Sir Richard Temple, in the present appeal, urged the necessity for the official recognition of anthropology as an essential part in the training of those members of the public services whose duties in remote parts of the Empire will bring them into contact with an alien or primitive culture. To this end he advocated the institution of an Imperial School of Anthropology of which the function should be both the training of the official and the collection and classification of the data gathered in the field by such trained officials and others, to form at once the subject-matter of the instruction given by the school and the basis of further research.

It is apparent that this proposal involves two ideas which in practice it will probably be found expedient to keep quite distinct. The question of training should stand apart from that of the organisation of anthropological study and research. Sir Richard Temple's suggestion in its original form as put forward at Birmingham was that the Imperial School might be constituted in connection with one of the universities. Yet it would be difficult to decide upon the claims of any one university, apart from financial considerations dependent to a large extent upon possible benefactions. Several of the universities now have facilities for instruction in some, if not all, branches of anthropology, and the number is increasing. Further, an officially recognised school in receipt of financial support from public sources would necessarily be subject in a greater or less degree to official control, a prospect which anthropologists cannot regard with equanimity. In the present state of the science freedom in method and in outlook is essential to the advancement of the study. Each centre must be free to work out its own salvation. Just as each university has its distinguishing characteristics, so each centre of anthropological teaching should develop along the lines which circumstances such as the character of the museums available for practical work or other local circumstances may dictate. With this development a stereotyped curriculum, whether in a central school or imposed upon all centres of teaching, would be incompatible. Nor is it without significance that centres of anthropological study and research are rapidly increasing in numbers outside this country. In India, in South Africa, and elsewhere, schools of anthropology are springing up. Sooner or later it may be hoped they will be in a position to make good their claim to inclusion in any organised scheme of instruction.

If, however, on these grounds it does not seem desirable to urge the institution of a central school, which, as Sir Richard Temple himself would probably agree, is little more than a matter of machinery, the training of the official is a

question of vital importance upon which it seems scarcely possible that there could be two opinions. It is significant that many of those who have insisted upon the importance of such training and given the proposal their strongest support have themselves been successful administrators. They point out that not only are sympathy and understanding essential in dealing with a primitive or alien population, but also that in acquiring such sympathy and knowledge by a long and sometimes painful experience an official must be guilty of many mistakes which a little training in anthropological method and outlook might have averted. It must be remembered that the training advocated is intended, not to turn out specialists in anthropological research, but to give the future official such a knowledge of primitive beliefs, institutions, and modes of thought as will enable him to acquire in a reasonably short space of time a sympathetic knowledge of the people with whom he has to deal, as well as make it possible for him to appreciate the bearing of the psychological and sociological factors which go to make up their culture as a whole.

Dr. Rivers, in the course of the discussion at Edinburgh, directed attention to a fact of extreme importance which is often overlooked. He pointed out that on the introduction of a civilised administration certain native customs are bound to be eliminated, but that it is necessary that such customs should be understood in all their bearings. Otherwise, owing to the interrelation of the constituent elements of a culture, the whole life of a people may be changed. It was to this that he attributed largely the dying out of certain backward peoples. The cause was psychological rather than material—they lost all interest in life. Anthropologists are familiar with more than one instance in which an ill-considered suppression of a native custom has had a grave effect on social structure, as, for instance, in South Africa, where interference with the "bride-price" affected the legitimacy of all native marriages. On the other hand, the attempt which is now being made in that Dominion to assist the social development of the native is based entirely upon a gradual and sympathetic adaptation of native institutions to conditions imposed by contact with a civilised community.

Happily the recognition of the bearing of these facts upon the preliminary training of the official is increasing. The training for the Sudan service instituted at Oxford and Cambridge at the request of Sir Reginald Wingate, when Sirdar, has, unfortunately, come to an end, but in other cases a short course of training is required. For instance, officers intended for the West African service are now being trained at London University. This requirement should be extended, and the institution of additional training centres should receive every encouragement. Nor should the needs of others than officials be overlooked. Facilities for anthropological study should be available for missionaries and traders in particular. Many missionaries, it is true, have availed themselves of the opportunities offered at Cambridge. Such a course of training should be regarded as an essential part of the missionary's equipment.

The value of a knowledge of anthropology as a commercial asset has not received adequate attention, though it is no less important for the trader than for the official. In view of the well-known conservative turn of mind of a primitive people, as well as the strength of their religious beliefs, in affecting their use of any given article, it is indeed surprising that so little attention is given to a study of cultural conditions as an antecedent to trading enterprise. A case often quoted is that of India, where the Germans before the war, by supplying canvas hold-alls in deference to native religious feeling, drove the leather article supplied by our manufacturers out of the market.

While the tendency of the discussion at Edinburgh showed that there was a general agreement as to the necessity for administrative officials to be trained in anthropology, it also emphasised the need for a central body to deal with the co-ordination and preparation of the material for such studies. The institution of such a central bureau is a question which was raised at a British Association meeting so long ago as 1895, and has been discussed on several later occasions. In 1908 the Royal Anthropological Institute, when Sir William Ridgeway was president, urged upon the Government the necessity for a central bureau and asked for a subsidy to enable it to carry out the work. Up to the present these efforts have not been successful.

It is scarcely necessary to dwell at length upon the functions which such a central bureau for anthropology should perform. The various teaching centres being concerned mainly with instruction and only incidentally with organisation, the collection and collation of data and their publica-

tion would best be undertaken by such a central body. The question of publication in particular is one which at the moment is becoming acute. Many of the younger workers in these days of high printing charges find a difficulty in securing facilities for publishing their work, and the same applies to officials who have made a study of the people under their charge. Publishers are unwilling to undertake the risk of publishing this material without a substantial subsidy which the authors are not, as a rule, able to afford. It is well known that at the present moment there is material dealing with the native peoples of our dependencies waiting to appear, which would, when published, be of the greatest value to administrators. Further, in the official publications of the various administrations there is much valuable material waiting to be made more readily accessible to students. The preparation of abstracts or even bibliographies of such material would be an essential function of the bureau. Owing to its position as a centre for the collection and collation of facts, and owing to the fact that it would be in close touch with those who could speak with authority on any and every part of the Empire, however remote, its value as an intelligence bureau would be incalculable, while Government departments, officers in the service of the Crown, missionaries, traders, and others, would naturally turn to it for information and guidance.

A duty of equal or even greater importance, though not so immediately apparent, would fall to this body in the diffusion of anthropological knowledge and the inculcation of an anthropological point of view among the general public. The need for such knowledge is becoming more urgent day by day for the proper understanding of imperial problems which we in this country or those in the Dominions are called upon to face. Further, it is often forgotten that anthropology does not deal exclusively with backward races or with the physical characters of the civilised. The culture and the underlying psychological basis of that culture among civilised races are equally within its scope. Even our own population is as yet a field which, anthropologically speaking, is largely unexplored. As was pointed out by Prof. Patrick Geddes and others at Edinburgh, it is the lack of the anthropological point of view in dealing with our own and other peoples which lies at the base of much of our present troubles.

Chemical Warfare.

The Riddle of the Rhine: Chemical Strategy in Peace and War. By Victor Lefebure. Pp. 279. (London: W. Collins, Sons, and Co., Ltd., 1921.) 10*s.* 6*d.* net.

EVERY great war within the last hundred years has been characterised by some new development in the means of offence, based upon the applications of science. Each successive war, in fact, is, in greater or less degree, a reflex of contemporary scientific knowledge concerning the most effective practicable measures by which belligerents may destroy human life; but it was reserved for the last great war—the greatest of all wars—to witness the introduction of a method of warfare which, in its savage ferocity and in its callous disregard of human suffering, is unparalleled in history. April 22, 1915, when the Germans sent great volumes of the deadly chlorine gas against the Allied lines, is a black-letter day in the annals of warfare. It was thought at first to have been a last desperate effort to dislodge the French from a position which all recognised methods of fighting had failed to take. The truth, however, is now beginning to appear. It was the first trial of a new war method, deliberately conceived and worked out by the Germans, even before the outbreak of war, and in flagrant disregard of their undertaking at the Hague Convention to abstain from the use of asphyxiating or deleterious gases. According to the author of the book before us,

"there is evidence that the Kaiser Wilhelm Institute, and the Physico-chemical Institute near by, were employed for this purpose as early as August, 1914. Reliable authority exists for the statement that soon after this date they were working with cacodyl oxide and phosgene, both well known before the war for their very poisonous nature, for use, it was believed, in hand grenades. Our quotations are from a neutral then working at the Institute. 'We could hear the tests that Professor Haber was carrying out at the back of the Institute, with the military authorities, who in their steel-grey cars came to Haber's Institute every morning.' 'The work was pushed day and night, and many times I saw activity in the building at eleven o'clock in the evening. It was common knowledge that Haber was pushing these men as hard as he could.' Sachur was Professor Haber's assistant. 'One morning there was a violent explosion in the room in which most of this war work was carried out. The room was instantly filled with dense clouds of arsenic oxide.' 'The janitors began to clean the room by a hose and discovered Professor Sachur.' He was very badly hurt and died soon after. 'After that accident I believe the work on cacodyl oxide and phosgene was suspended, and I believe that work was

carried out on chlorine or chlorine compounds.' 'There were seven or eight men working in the Institute on these problems, but we heard nothing more until Haber went to the Battle of Ypres.'"

Ludendorff, in his "War Memories," refers to the valuable services of Geheimrat Haber in connection with the use of gas.

That what has come to be known as "chemical warfare" was intended by the Germans to be the novel and distinguishing feature of the war they had so sedulously planned was abundantly proved by its subsequent course. The *liaison* between the German G.H.Q. and the Interessen Gemeinschaft, the organisation which controlled the great chemical manufacturing establishments of Germany, was complete. It was mainly through the agency of the I.G. that in the first place Geheimrat Haber and his colleagues were furnished with the poisonous products they needed for their trials, and it was the I.G. that directed the Badische Anilin- und Sodafabrik at Ludwigshafen, the chemical factory at Berlin, of which the late Dr. Martius was the head, Höchst, Leverkusen, and the rest of the great Rhine dyestuff-producing works, all working in concert, to supply the various lethal substances, eighteen at least, which it was eventually decided to employ. The I.G. organisation was comparatively simple. It lay ready to hand, and could be promptly set in motion with no bureaucratic friction and no official delays. Much of the plant needed to produce synthetic dyes could equally well produce synthetic poisons, and the apparatus was of a type that could be rapidly augmented if necessary.

It was these conditions which, no doubt, in the first instance, led the Germans to plan their new war method. The unique position of their great manufacturing establishments, with their special machinery and experience, their perfect organisation and scientific direction, their intimate co-operation, their hundreds of trained chemists, and their thousands of skilled workmen, gave them an overwhelming advantage over their enemies. The marvel is that they should have ultimately failed. They had the initial advantage of surprise, and at one period it is certain that the way to the coast, which it was their objective to reach, was open to them; but by the mercy of Providence they were made blind to their opportunity, and we all know the sequel. It was that the Allies eventually beat the Germans at their own game.

What we are now concerned to know is whether the game is to continue. Has chemical warfare come to stay? Military experts apparently halt between two opinions. The issue would seem to rest with Germany. This issue will give her pause to think. Those who seek to guide her policy must take stock of her position as the war has left it. Is she in the same strong position now in regard to her organic chemical industry that she occupied prior to 1914? If, with the condition of that industry as it was in all the Allied countries at that period, she yet failed, what chance would she have now? The development of applied organic chemistry in this country, in France, or in America, is not at present all that we might wish to see it, or as assuredly it will be in the not remote future, but it is still very considerable. Each country is immeasurably better able to withstand the German menace of poison gas, and, if necessary, to retaliate with it, than it was half a dozen years ago.

We have learned by experience. The initial advantage of organisation and surprise in the production and military use of poison gas no longer rests with Germany—at least, to nothing like their former extent. She has already paid dearly, both morally and materially, for her breach of the Hague Convention to which she had subscribed, and it is not difficult to suggest means whereby she can be still further penalised should she fail to give adequate assurance, when required, that she means to abandon the new war method she has initiated. Should she be required to abandon it? This is a matter which surely falls within the purview of the Washington Conference on disarmament. The Covenant of the League of Nations has already incidentally dealt with it. Article 8, however, requires to be more explicitly directed to it. Moreover, the power of the League needs to be strengthened to enable it to deal more effectively with breaches of its regulations.

If the German menace were removed there would probably be little difficulty in securing international agreement among members of the League to ratify once more the article of the Hague Convention to "abstain from the use of projectiles the object of which is the diffusion of asphyxiating or deleterious gases." Germany cannot continue to remain outside the League. Sooner or later she will put herself in order and apply to come in. Her national position and her future as a world-Power will require it. Once a member she must subscribe to, and must obey, its conditions. It must rest with the League to enforce, if necessary, Germany's obligations. The loss of the markets of the world for the products the Interessen Gemeinschaft controls might be the least of the penalties she might be made to incur for a breach of them.

The whole story of the inception and development of gas warfare by Germany has still to be

told. Schwartes's book, "Die Technik im Weltkriege," throws some light on the subject from the German side, and we have references to it in such works as Ludendorff's "War Memories." The report of the Hartley mission to the German chemical factories in the occupied zone, and Gen. Hartley's report to the British Association, taught us much and revealed the intimate association of the all-powerful I.G. with the German War Department. Major Lefebure, in the work under review, has undoubtedly made the most considerable contribution to the history of chemical warfare which has yet appeared. He has described its rise, the nature of the various lethal substances employed, the modes of protection, the efforts of the Allies to retaliate, the successive attempts to secure the initiative, and chemical warfare organisation in Germany, in this country, and in America. He has said comparatively little respecting France, but its story has been admirably told by Prof. Moureu in his "La Chimie et la Guerre," already noticed in these columns.

The weakest point of Major Lefebure's book is its constructive policy. He proposes to counter the German menace by breaking down the German monopoly in the manufacture of synthetic dyestuffs. This, he says, can be done only by what he calls "a redistribution of organic chemical forces. This, indeed, is the one solid chemical disarmament measure which can and must be brought about." But how? By interfering with "the play of ordinary economic laws." Who is to interfere? The League of Nations. Surely this is not even a counsel of perfection. Nobody, however powerful, can long resist the play of ordinary economic laws. As somebody has observed, the result would be that the economic laws would come back at you like a punch-ball.

T. E. THORPE.

Alfred Newton, Ornithologist.

Life of Alfred Newton, Professor of Comparative Anatomy, Cambridge University, 1866–1907. By A. F. R. Wollaston. With a preface by Sir Archibald Geikie. Pp. xv+332. (London: John Murray, 1921.) 18*s*. net.

DURING the fourteen years that have elapsed since the death of Prof. Newton many of the older members of his circle who had eagerly anticipated the perusal of this volume have passed away, but every British ornithologist will welcome an account of one who for half a century was the leading exponent of the science in this country—one, too, whose remarkable influence in all matters relating to the study of bird-life can be fully realised and appreciated only by those who had the good fortune to participate in his friendship. As Prof. Newton kept voluminous journals and seldom destroyed a letter, the work, as Sir Archibald Geikie points out in his preface, has been given largely the character of an autobiography. With this wealth of material at his disposal, it is greatly to be regretted that the author has found it necessary, owing to the increased costs of publication, to reduce the volume by nearly half its bulk, and we feel certain that a bolder policy in this respect would have entailed no loss. Mr. Wollaston, however, has made a careful selection of his material, and has succeeded in producing a vivid picture of the varied activities and interests of a life of such fullness as is vouchsafed to but few, drawn from the professor's own letters and journals, and from the correspondence and recollections of those who were intimately associated with him.

Students of the history of zoology in this country will find much new information in the chapters dealing with the foundation, in Newton's rooms at Cambridge in 1858, of the British Ornithologists' Union and its journal, *The Ibis*, and with the part played by Newton in the early promulgation of the doctrines of Darwin and Wallace.

Much may be learned from the glimpses that are given us of Newton's methods of work and of the extraordinary pains he took to ensure that perfect accuracy, even in the smallest details, which characterises everything that he published, and renders it as perfect as human effort could make it at the time. His greatest work, the "Dictionary of Birds," displays research and scholarship unparalleled in ornithological literature, and must ever remain one of the classics of the science. Newton's desire for completeness prevented the publication of works on the great auk or gare-fowl, and the history of the great bustard in Britain, for which he had been collecting material for many years. It is to be hoped that the attention now directed to this vast store of material may lead to its speedy editing and publication.

Space will only permit of a reference to the character-sketch contributed by Dr. F. H. H. Guillemard. Here we see the professor in his study in the Old Lodge at Magdalene—"the nest in which *The Ibis* was fledged"—where every Sunday evening he was at home to any member of the university who was interested in zoology. It was here, rather than in the lecture room, that his influence on zoological thought at Cambridge was exerted. To quote the apt remark of Sir A. Shipley, "Newton's Sunday evenings saved zoology as the science of living animals in Cambridge."

W. E. C.

Fruits of the Tropics and Subtropics.

Manual of Tropical and Subtropical Fruits: Excluding the Banana, Coconut, Pineapple, Citrus Fruits, Olive and Fig. By W. Popenoe. (The Rural Manuals.) Pp. xv+474+24 plates. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1920.) 30*s.* net.

A CONSIDERABLE literature on the more important fruits of tropical and subtropical countries exists, much of it in the form of bulletins or articles in journals which are not easily accessible to all who require them. A volume in which all the more valuable information so widely distributed had been collected would have proved a boon to many. Such a purpose Mr. Popenoe's manual has, in a large measure, fulfilled. But the work is far from being a mere compilation. The author has drawn freely on the writings of others, as he admits, but his wide knowledge of the subject has enabled him to select critically from the material at his disposal, and having travelled extensively in tropical and subtropical regions as agricultural explorer for the United States Department of Agriculture, as well as having had practical experience in fruit-culture in California and Florida, he has produced a volume based largely on his own observations and experiments. Certain well-known fruits, as pointed out on the title-page, have been excluded for the reason that they have been already dealt with in other volumes, while the term "fruits," as understood in the volume under notice, does not include nuts.

The work is divided into sixteen chapters, the first being an excellent article on the outlook for tropical fruit. Then follow chapters on the following and related fruits: The avocado, the mango, the annonaceous fruits, the date, the papaya, the loquat, fruits of the myrtle family, the litchi, the sapotaceous fruits, the kaki, the pomegranate and the jujube, the mangosteen, the breadfruit, and miscellaneous fruits, among which are included the durian, carambola, tamarind, and tree-tomato. Before the index there is a brief bibliography, and in addition to the twenty-four half-tone plates there are sixty-two line-drawings in the text. The book is well printed and in every way a worthy companion to the many excellent works comprising "The Rural Manuals," edited by Dr. L. H. Bailey. We have no doubt that it will be regarded, as it deserves to be, as one of the standard books on tropical and subtropical fruits.

There are probably few fruits of much importance, in addition to the six named on the title-page, that are not included in the work, though in some cases the information given about them is necessarily very meagre. We observe that none of the Cucurbitaceæ is mentioned. Most of the fruits of this family are apparently outside the scope of the volume, though *Acanthosicyos horrida*, the narras or 'nara, a native of south-west tropical Africa, is one that might have been included, for it appears to have qualities that would render it an invaluable plant for hot, dry, sandy regions, where very little vegetation of any kind is found. The late Prof. H. H. W. Pearson said of it in the *Kew Bulletin*, 1907, p. 344: "For about four months in the year the fruits and seeds render the Hottentots independent of other sources of food, and to some extent of water also."

Our Bookshelf.

How to Teach Agriculture: A Book of Methods in this Subject. By Prof. Ashley V. Storm and Dr. Kary C. Davis. Pp. vii+434. (London: J. B. Lippincott Company, 1921.) 12*s.* 6*d.* net.

DRS. STORM AND DAVIS have produced a book entirely for the teacher; they develop some interesting ideas and make a number of suggestions which cannot fail to be helpful. The book contains an interesting chapter on teaching through charts, slides, and films, which could be read with advantage by many agricultural teachers in this country. The authors state that the use of films as a means of teaching is rapidly gaining ground in America. The expense of the projecting machine is being reduced by the manufacture of smaller and less costly models, while the expense of the films is being lessened by more economical methods of manufacture. Teachers and producers are co-operating in making films that are actually, and not merely ostensibly, educational, while the inefficiency of the film service is being overcome by the development of co-operation between schools, colleges, and commercial and teachers' organisations.

The Electrical Transmission of Photographs. By M. J. Martin. Pp. xi+136. (London: Sir Isaac Pitman and Sons, Ltd., 1921.) 6*s.* net.

ALTHOUGH the transmission of photographs over telegraph circuits may still be said to be in the experimental stage, a number of processes have been developed to a considerable extent, and already pictures are sent over the London-Paris and other lines to a limited extent in illustrated journalism. The author summarises the work of various inventors in this field, and the processes described include those depending on the action of light on selenium, and those in which a stylus travels over a metallic image. Full instructions are given for the construction of an experimental equipment, and a chapter is included referring briefly to the wireless actuation of such apparatus.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Age of the Earth.

At the discussion on the age of the earth at Edinburgh we were unfortunately prevented from hearing Dr. Jeffreys's contribution owing to lack of time. I have, however, read it with interest in NATURE of October 27. My only object in writing now is to demur to an allusion in it: "Lord Rayleigh's suggestion that the earth must be becoming hotter." The words I used were carefully qualified, and I do not think that I can do better than quote them: "If [the radio-active materials present in the earth] are generating more [heat than is now leaking out from the earth] (and there is evidence to suggest that they are), the temperature must, according to all received views, be rising."

I appreciate the difficulty of such a supposition as clearly as Dr. Jeffreys. RAYLEIGH.

Terling Place, Witham, Essex, October 31.

Inheritance, Mendelism, and Mutation.

In NATURE (August 18, pp. 780–84) appears an article by Prof. Goldschmidt on "The Determination of Sex." The author supposes he is dealing with inheritance. At any rate, Mendelians suppose they deal with inheritance, and he declares "we may safely say that to-day, in the light of Mendelism and the work accomplished in the realms of cytology, the problem is solved as completely as the methods of biology permit." Very probably the odd-chromosome of which he writes has influence; but very massive evidence indicates that sex is determined mainly, not by the nature, but by the nurture of the individual—by such things as hormones from the sex-glands, food, temperature, and the like. In other words, it is certain that both sets of sexual characters are *inherited* by the individual, but, except in true hermaphrodites and in "intersexuality" (abnormal blending), only one set is *reproduced*. Male is undeveloped female, and *vice versa*. There is alternative patency and latency, alternate *reproduction*, not alternate *inheritance*. But the alternation is often irregular. For example, in aphides, during a long and indeterminate series of generations, the male characters are latent.

So far as it is possible to judge from ordinary experience of life, offspring appear to blend most parental characters, as is best seen when, within limits, the parents are much unlike. For example, when blue-eyed Scandinavian crosses with black-eyed negro, the result is a mulatto, who, though he may incline more to one parent than to the other, is conspicuously a blend. Mulattos, mated together, continue to breed true, but if succeeding matings be with pure white the touch of the tar-brush grows fainter generation after generation. In sexual characters and eye-colour there is, however, no apparent blending. The child is male *or* female, with, almost invariably, black eyes—black dominating over blue. But do sexual characters and eye-colour furnish evidence that there is here no blending? Is it reasonable to expect the male characters to blend with female characters? Is this what happens in the case of truly hermaphrodite animals and plants when both sets of sexual organs are patent? For example, do stamens blend with pistils? Plainly, except in cases of "intersexuality," when the male and female characters do blend more or less, if there is any blending, it is between the patent male characters of the one parent and the latent male characters of the other. So, also, with the female characters.

Similarly with eye-colour. With at least rare exceptions, mulattos, no matter for how many generations interbred, have black eyes. The black continues dominant. But if each succeeding generation mates with white, then at length blue eyes *suddenly* appear. How could this happen if the inheritance, not merely the reproduction, were alternate? The black would then remain as dominant in the octoroon as in the mulatto. But with the inheritance of both characters and the reproduction of only one the thing is comprehensible. Each reinforcement of blue then weakens the dominance of the black until at last blue becomes dominant. Much the same appears to happen in the case of human monstrosities—idiocy, hare-lip, club-foot, and the like. Here normality is dominant until the conditions of nurture are in some way altered—*e.g.* by the reinforcement of the monstrous strain. Apparently, then, the long latency of the blue eye-colour is comparable with the similar latency of the male characters in aphides.

What is a mutation? As well as I am able to judge from literature, it is a character the reproduction of which is Mendelian, and which, very commonly, is of "wide amplitude," a "sport." It has been said that, "unlike fluctuations which are responses to nurture, mutations have representatives in the germ-plasm." But this is merely a misuse of language, for since all characters are products of germinal potentiality and fitting nurture, all must be equally germinal and somatic. As already indicated in a former communication (NATURE, August 25, pp. 808–10), whenever we are able to observe natural selection actually at work, its choice is obviously among fluctuations, not mutations. Thus every shade of susceptibility to tuberculosis may be observed; for in the same surroundings some individuals resist disease altogether, others recover more or less quickly from illness, while others die after long or short illnesses; in different localities the stringency of selection is different; races have been afflicted by the bacillus during diverse durations of time, and every race is resistant in proportion to the length and severity of its past experience. Moreover, the inheritance is blended; thus half-breeds (*e.g.* Europeans crossed with Asiatic, negro, and American Indian) are susceptible in proportion to the blended susceptibilities of their ancestors. For example, Eurasians commonly survive in the cities of the temperate zones, where American half-breeds almost invariably perish. It is probable that few of the American Indians and Maoris and their half-breeds that came to and survived the Great War have returned home to live.

On the other hand, as Darwin noted, man "often begins his selection by some half-monstrous form, or at least by some modification prominent enough to catch the eye, or be plainly useful to him." Man is in haste to get results, and usually cannot observe small differences in races other than his own. Thus even the natives of China seem to an Englishman newly arrived as like as peas in a pod—as doubtless they are. In some cases, however, man is obliged to rely on fluctuations—as in breeding for speed in horses, when a thousand co-ordinated structures are involved. A thousand co-ordinated mutations occurring in one individual are almost inconceivable. It seems, then, that natural selection, which works for the benefit of the individual and his race, chooses fluctuations, while artificial selection, which works for the benefit of man, relies largely on mutations.

It is agreed that fluctuations blend. The following then are the rival suppositions:—(*a*) That the inheritance of Mendelian characters is alternate, and (*b*) that only the reproduction of them is alternate; (*a*) that Mendelian characters do not blend, and (*b*) that they do blend (not with the alternate character, but with the similar character, latent or patent in the mate); (*a*) that Mendelian characters are stable and can be eliminated only by selective breeding or by retrogressive mutations, and (*b*) that they fluctuate, and therefore are liable, when useless, to undergo retrogression like other useless characters; (*a*) that the function of sex is to mix characters as marbles of two colours are mixed in a bag, and (*b*) that the function of sex is to blend characters as two paints are blended on a palette (apparently the result of this blending is retrogressive through a preponderance of retrogressive variations; hence the decrease and ultimate disappearance of useless characters, including mutations, whereby the race is stripped of redundancies as an athlete is stripped for a race; in this way, presumably, the life-history of the race has been shortened until recapitulation in development is possible); (*a*) that species and varieties have all originated through mutations, and (*b*) that all natural species and varieties have originated and evolved through the selection of fluctuations, while the selection of mutations has played a great part in the creation of artificial varieties; and finally (*a*) that like does not necessarily beget like when parent and offspring develop under like conditions (for if the doctrine of the Mendelian *inheritance* be true, the pure extracted recessive is by nature unlike the impure dominant parent whence it is derived), and (*b*) that apart from variations, like does exactly and necessarily beget like under like conditions of nurture—for example, a daughter would have developed male traits like her father had her nurture been similar.

Now let us seek crucial examples. Their discovery should not be difficult among the vast collections of facts which have been recorded about living beings. If the *inheritance* (not merely the reproduction) of Mendelian traits is alternate, how is it possible to account for the oft-observed reappearance in *purely bred* domesticated varieties of long-lost ancestral characters? According to Mendelian theory such traits should have been totally eliminated perhaps hundreds, or even thousands, of generations before from the "pure" dominants and recessives that are supposed to have carried on the heritage. As Darwin noted: "We see that in purely bred races [of pigeons] of every kind known in Europe, blue birds occasionally appear having all the marks which characterise *C. livia*." "Purely bred Game, Malay, Cochin, Dorking, Bantam . . . and silk fowls may frequently be met which are almost identical in plumage with the wild *G. bankiva*." "Pure" extracted recessives have given dominant offspring, and *vice versa*. Many similar cases might be cited. If "the central phenomenon of Mendelian heredity is segregation," not even the reunion of disunited factors and determiners can account for these reversions; for if the breeding has been *pure*, then reunion, *ex hypothesi*, is inconceivable. In parenthesis, it may be noted that an individual may resemble a remote ancestor in two ways:—(1) He may reproduce a dormant ancestral trait, thereby rendering latent the alternate character which had been patent in his immediate predecessors; or (2) he may, through a failure in nature or nurture, fail to recapitulate the life-history of his race beyond the point reached by an ancestor and by himself as a fœtus—for example, "Occasionally a foal is born with two hoofs on one or more of its limbs; at long intervals a foal appears with three hoofs on one or more of its limbs."

"The fact that the gametes of the cross transmit [or reproduce] each member of the pair pure is as strong an indication as can be desired of the discontinuity between them." If that be so, the converse must be true also—the fact that the gametes of the cross transmit each member of the cross blended is as strong an indication as can be desired of the continuity between them. In other words, if offspring reproduce divergent parents unblended, then there is a presumption that one or other, or both, of each pair of differences arose through mutation; but if there is blending the presumption is that the unlikenesses arose through fluctuation, it may be through the accumulation of many successive fluctuations. For example, since in the crossing of white and black human races eye-colour does not blend, it is probable that this particular unlikeness arose through mutation (and, since British eyes are of many colours, that we are a very hybrid race). On the other hand, since skin-colour blends, it is probable that this colour difference arose through the accumulation of fluctuations. Similarly, if the progeny of racehorses crossed with ordinary horses do not blend hair-colour, but are intermediate as regards speed, the presumption is that the divergency in hair-colour arose through mutation, but that in speed evolved through fluctuations. Now comes the point I am driving at. *When we cross artificial varieties we frequently discover instances of alternate reproduction, especially in traits which are not vital for existence. But when we cross natural varieties (which carry few superfluities) we almost invariably get blending in nearly everything except sex and characters associated with sex (for example, human eye-colour, which is an attraction).* A few years ago there was a beautiful example of blending in the London Zoo in a cross between brown and polar bear, recrossed with the latter. Essentially it was a case of mulatto and quadroon.

But the crossings of natural and artificial varieties reveal another significant difference. Darwin wrote: "Besides visible changes which it [the germ] undergoes, we must believe it crowded with invisible characters proper to both sexes, to both the right and left sides of the body, and to a long line of male and female ancestors separated by hundreds, and even thousands, of generations from the present time; and these characters, like those written on paper in invisible ink, lie ready to be evolved whenever the organism is disturbed by certain unknown conditions. . . . We conclude that a tendency to this peculiar form of transmission is an integral part of the general law of inheritance." But if we study the evidence which Darwin cites and which led him to this conclusion, it becomes plain that he relied altogether on facts derived from artificial varieties. So far as I know (with one doubtful exception, *Kalenchoe flammea* crossed at Kew with *K. Bentii*), there has not been recorded a single instance of the reappearance of a *latent* ancestral trait when natural varieties have been crossed; but the crossing of artificial varieties has revealed multitudes of them. Often they have appeared even when there is no crossing, as in pigeons, fowls, and many plants—hence De Vries's "ever-sporting" varieties.

Of all the foregoing the human race affords excellent illustrations. Man is a natural species, divided into a multitude of natural varieties. Where there has been perpetual war, accompanied by the killing of the vanquished, as in Papua, almost every valley and island has its biologically distinct race. Obviously, lack of intercourse (interbreeding) swiftly produces racial divergence, which steadily increases generation after generation—as witness the great unlikenesses between races separated by great distances, and therefore long durations of time. Human written history

has a duration of four thousand years; men are fond of recording wonders; yet never has a useful and persistent human mutation been recorded.

Judging, then, from crucial examples, (1) natural varieties have evolved by way of fluctuations, but artificial varieties in great measure by mutations; (2) there is no Mendelian segregation, but only Mendelian reproduction; (3) blending is universal; and (4) apart from variations (including the results of blending), like, always and necessarily, begets like when parent and child develop under like conditions of nurture.

Surely it is evident that if we use precise language (as Darwin tried to do), and bring all the available evidence into court by means of crucial examples (as Darwin did), the dust which Neo-Lamarckians, Neo-Darwinians, and the rest of the sects have flung into our eyes will be washed away, and our very great man will come into his kingdom again.

G. ARCHDALL REID.

Methods of Improving Visibility.

THE observations of Prof. C. V. Raman (NATURE, October 20, p. 242) on a method of improving the visibility of distant objects by the elimination of reflected light by means of a Nicol's prism placed in the eye-piece of a telescope are certainly interesting, but at the same time they are thoroughly well known, and the idea of increasing the visibility by the elimination of polarised light has received a great deal of attention lately. During the war a considerable amount of experimental work was carried out by the Admiralty in connection with fog-penetration and the beamless searchlight, both of which dealt with polarisation phenomena. It was, however, found advisable to substitute for the Nicol's prism as used by Prof. C. V. Raman a few plates of plain glass placed obliquely at a suitable angle across the axis of the particular instrument, since it is extremely difficult to make really large Nicol's prisms, in addition to which the actual absorption by Nicol's prisms is rather excessive. The matter was also taken up by the late Sir William Crookes, and formed the basis for lenses cut from quartz crystals at right angles to the principal axis, thus utilising the rotary polarising effect of this material. I have lately been using tourmaline for obtaining a similar effect, and I have found that a very thin plate of tourmaline cemented as a semi-lens on to an ordinary pair of spectacles is best for this purpose.

Tourmaline is a mineral that has found a great deal of application lately, and particularly during the war in connection with the piezo effect, in the apparatus used for the detection of submarines and submarine-sounding, and is, in consequence, fairly abundant. For this purpose the plates of tourmaline are cut perpendicular to the vertical axis, but the maximum polarising effect is obtained from plates cut parallel to this axis. Thin plates of this material, when so cut and fixed into the spectacles as mentioned, give an effect the benefits of which can only be realised when put to the actual test. Thus, for example, when fishing, the injurious glare from the water is entirely eliminated. At the same time the eye is able to penetrate the water to considerable depths. This fact will, of course, be appreciated by those engaged in the study of pond-life.

A further application is the manufacture of spectacles for invalids and others residing at the seaside, whereby, again, the glare of the water is almost entirely eliminated and the delightful tone of the tourmaline is very restful to the eye. In photography a further application consists in using a sheet of tourmaline as a light-filter, whereby reflection, and in particular that from shining objects, is largely eliminated; and while it is not possible to take photographs of water directly facing the sun, many pictures which are otherwise impossible can be taken by means of this screen.

A final application, and one with which my experiments originated, was the examination of photomicrographs, which, owing to their delicate nature, were of necessity mounted below a sheet of glass. The continued observation of these objects was found to be a very tedious process owing to the brilliant light required and the consequent reflection from the glass. This reflection was again eliminated by the tourmaline. The plates of tourmaline must, of course, be so mounted that the vertical axis is placed vertically in the spectacles.

These applications have already been provisionally protected at the Patent Office, but up to the present I have found no firm that will take up the manufacture of such glasses. I am confident, however, that a very useful industry awaits the firm with the necessary enterprise.

A. G. LOWNDES.

Marlborough College, Wilts, October 28.

PROF. C. V. RAMAN'S suggestion (NATURE, October 20, p. 242) for improving visibility at sea was put forward by me some years ago in "Elementary Seamanship" (Griffin and Co.), and is useful not only for objects above the surface, but for those—like coral-reefs—some little distance below the surface. In the last instance, when there is a slight ripple on the surface of the water it is often difficult to detect them even when navigating with the sun astern. The use of the Nicol prism clears up in a great measure this difficulty.

DAVID WILSON-BARKER.

Flimwell, October 28.

Penial and Genital Setæ of Lumbricus terrestris, L., Müll.

ON p. 172 of Prof. O'Donoghue's "An Introduction to Zoology for Medical Students," reviewed in NATURE of August 11, it is stated that in *Lumbricus herculeus* (the name is a synonym of *L. terrestris*) "in the fifteenth segment the two pairs of ventral setæ lying close to the male external aperture are modified to form the penial setæ." In Bourne's "An Introduction to the Study of the Comparative Anatomy of Animals," vol. 2, pp. 19–20 of the fifth edition, 1912, it is said that in the same worm "the chætæ of the clitellar region differ from those of the rest of the body, being finer and nearly straight, with hooked inner ends. There is also a pair of modified chætæ in somite 15." Borradaile, in "A Manual of Elementary Zoology," p. 217 of the third edition, 1920, says, "The ventral setæ of the clitellum, of the 26th and of the 10th to the 15th segments are straighter and more slender than those of other segments, which are stout and somewhat hooked. The modification is in connection with the use of the setæ of the 26th segment during coition, and of the other straight setæ during the formation of the cocoon in which the eggs are laid." Parker and Haswell, in "A Textbook of Zoology," p. 455 of the second edition, 1910, state that "the setæ in the clitellum, and those in the neighbourhood of the genital apertures, are much slenderer than the rest."

Systematic writers, however (to whom modifications in the form of the setæ are of importance as furnishing specific characters), do not appear to have recognised the presence of penial setæ in segment 15 of *Lumbricus terrestris*. Thus Beddard, in "A Mono-

graph of the Order of Oligochæta," 1895, p. 122:—"Genital setæ associated with the male-pores only occur in the Megascolicidæ, the Eudrilidæ, and (rarely) in the Geoscolicidæ, Lumbriculides; in fact, they only occur in those families of terrestrial Oligochæta in which the male-pores are provided with spermiducal glands"; he notes (p. 688) that the clitellar setæ of the Lumbricidæ are commonly modified in shape, being very much longer and thinner than those on the non-clitellar segments. Michaelsen, in the Tierreich volume on Oligochæta, 1900, p. 470, gives as a family character of the Lumbricidæ that commonly the setæ on certain segments of the anterior part of the body are situated on papillæ, and modified as genital setæ in the form of "Furchenborsten," with longitudinal ridges and one or more intervening grooves at the distal end. In *Lumbricus terrestris* (p. 512), "Usually the ventral setæ of segm. 26 or (less often) 25 and 26 are situated on broad papillæ and modified as grooved genital setæ, slender, curved only at the proximal end, 1·6 mm. long and 45μ thick."

The above statements are not in all respects concordant. The fullest of them, that of Borradaile, can apparently be traced back, through Vejdovsky's "System und Morphologie der Oligochæten," 1884, p. 156, to Hering's paper in the *Zeitschrift für wissenschaftliche Zoologie*, vol. 8, 1857, p. 418, who states that peculiar setæ are found in *Lumbricus agricola* (another synonym of *L. terrestris*) in the ventral series in the tenth segment, in the fifteenth or one of the adjacent segments, in the region of segment 26, and, lastly, in the clitellar segments (31–38); these peculiar setæ are thinner and about double the usual length.

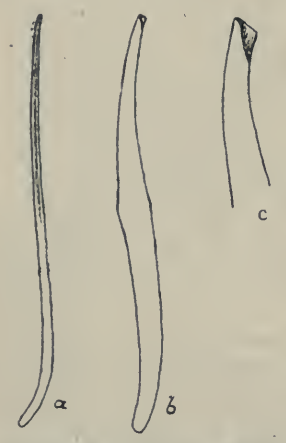

FIG. 1.—(*a*) Clitellar seta of *Lumbricus terrestris* (×30). (*b*) Ventral seta of segment 15 (×64). (*c*) Tip of ventral seta of segment 15 (×188).

Some of the authors quoted above do not mention any modification of the setæ near the male apertures; of those who do mention it some do not say in what the modification consists, and those who describe it state that it is the same as the modification in certain other segments, *e.g.* those of the clitellum.

I have examined three specimens of *Lumbricus terrestris*, all with the clitellum and "ridges of puberty" (on segments 33–36) fully developed; as shown by the condition of the spermathecæ, two had copulated, one apparently not. For comparison, an unmodified seta (a ventral seta of segment 17) was taken; this was of the well-known type, in length 0·74 mm., with the nodulus distal to the middle of the shaft (portion distal to nodulus is to portion proximal to nodulus as 2 is to 3).

In segments 8–10 the ventral setæ were much more massive than usual, and about 1·24 mm. long, but of the ordinary type (the larger size of the ventral setæ in the anterior segments can be appreciated on examining the surface of the worm with a lens). In segments 12–14 some setæ were massive, like those just described, while some were of about normal size (0·82 mm. long) or slightly larger (0·91 mm. long).

The ventral setæ of segment 15 were not discovered in one of the worms, perhaps because they had fallen out; in both worms which possessed them they were 0·87–0·91 mm. long, with nodulus about the middle, the shaft gradually tapering from nodulus to tip, and only slightly curved (Fig. 1, *b*); the tip was excavated, somewhat like a sugar-scoop (Fig. 1, *c*). The lateral setæ of this segment are of the usual size and type.

The ventral setæ of segments 25 and 26 were not at all modified in type, though they were rather larger than the one taken for comparison (0·96, 1·07, 1·17, and 1·2 mm. long).

The setæ of the clitellar segments correspond to the descriptions of the authors quoted. They were 1·85 mm. long, slender, with no distinct nodulus, though the shaft was thickest a little above the proximal end; there was a marked proximal curve, and the shaft was almost straight in the rest of its extent; it tapered very gradually and ended in a blunt point, and was grooved or ridged along its sides in the distal half (Fig. 1, *a*).

In the specimens examined, therefore, the only modified setæ (apart from variations in size) were those of segment 15 and of the clitellum. The modification of the clitellar setæ was that described by certain of the authors above quoted; but that of the ventral setæ of segment 15 was of an altogether different type, which apparently has not hitherto been recognised.

J. STEPHENSON.
Zoological Department, Edinburgh University, September 29.

Speaking Films.

IN the article on speaking films which appeared in NATURE of October 27 Prof. Rankine says: "Combinations of picture films and ordinary gramophones have been frequently tried without success sufficient to ensure their survival in practice. The difficulty, of course, mainly arises from the impossibility of *preserving* synchronism between a gramophone record and film."

This mechanical difficulty could be overcome, at least in the early stages of the life of a film, but even then a more serious difficulty, which may best be described as psychological, would remain. It must be remembered that both by the film pictures, the film sounds, or the gramophone sounds deceptions are practised on the human senses. The eye is deceived into believing that it sees real people in movement when it is doing no more than witnessing the antics of graduated shadows. If the film fails to deceive the sense of seeing, it fails also in its psychological effect. The intimacy with which devotees of the "pictures" speak of the "film stars" who are "featured" shows that they do indeed believe that they see them, that it is actually Charlie Chaplin or Mary Pickford who is present before them. It is only when the senses surrender themselves completely to this deception that the emotions are fully affected.

In the same way the gramophone deceives the sense of hearing. Unless we can actually believe that we hear Caruso or Sir Harry Lauder the enjoyment and the effect will remain partial.

Now, my own experience is that you may deceive one sense at a time, but not two. You may deceive the eye with the film or the ear with the gramophone, but if you attempt to deceive both together failure results and both deceptions are destroyed. Some years ago I witnessed a film which showed a nigger dancing to a banjo. As long as he only danced I forgot that he was a black-and-white picture on a white sheet, but when a gramophone attempted to render the words of his song and the banjo accompaniment the illusion disappeared. There was no appearance whatever of a nigger singing. What I

saw was a shadow moving on a screen; what I heard was a gramophone making noises with all the familiar defects.

It is quite possible that in this case the synchronisation of film and record was not perfect, and that its inaccuracy helped to destroy the illusion, but it must be remembered that both one and the other—as Prof. Rankine indicates in the case of speech records—depend in great measure upon suggestion. The dominant part of a word gives us the key to the whole. Both words and pictures are scientifically "imperfect," and when we attempt to amalgamate them the resultant imperfection is so great that the effect is wholly lost. LOUGH PENDRED.

33 Norfolk Street, Strand, London, W.C.2,
October 28.

FROM practical experience I am able neither to confirm nor to contradict Mr. Pendred's interesting observations on the difficulty of practising simultaneous deceptions on the senses of seeing and hearing. It is quite possible, of course—perhaps likely—that it is easier to produce one such effect than both at once; but I can see no reason, *a priori*, for expecting the double deception to be impossible. It must be remembered that both moving pictures and ordinary gramophones have been improved greatly during the years since Mr. Pendred's experiences, and that, could perfect synchronisation be guaranteed, the results he describes might now be modified considerably. Mr. Pendred would, I think, admit that if both pictures and sounds could be sufficiently improved, the remaining imperfections, even though, possibly, additive, might yet be so small that the deceptions aimed at would both be effective.

There is no doubt that the photographic and photo-electric method of recording and reproducing sounds is much superior to the comparatively coarse methods used in ordinary gramophones; and this may quite well be a reason, in addition to the attainment of synchronisation, for the success of the talking pictures produced by Mr. Bergland, and spoken of so highly by the *Times* correspondent and by Prof. Arrhenius. A. O. RANKINE.

Royal College of Science, South Kensington,
London, S.W.7, November 2.

The Differentiation of Boiled and Unboiled Water.

IT is often desirable to be able to ascertain whether water alleged to have been boiled for drinking purposes has in reality undergone the treatment. This may be readily determined by means of indicators appropriate to the type of water, for the effect of boiling is always to lower the hydrogen-ion concentration by removing carbon dioxide from solution and decomposing bicarbonates.

For example, Plymouth tap-water, a soft water from Dartmoor, is now at pH6·8, and gives a yellowish colour with phenol-red. On boiling in a hard glass test-tube it develops the full red with this reagent, a light pink with phenolphthalein, and a yellowish colour with thymol-blue. It is then at pH8·5.

Youghal tap-supply is at pH7·0, but contains far more bicarbonate than Dartmoor water, since on boiling it not only gives the full red with phenol-red, but also gives a more intense colour with phenolphthalein and a slaty-blue with thymol-blue, denoting pH9·0, the limit for water saturated with calcium carbonate in absence of carbonic acid.

Water from Blagdon Reservoir (Bristol supply) was found to be at pH7·8, and at Pusa, in Bihar, the laboratory tap-water is at pH8·1, that of the River Gandak from which it is derived being somewhat more alkaline. Running streams may be up to pH8·3 even when derived from wells at pH6·4. Saunders (Proc. Cambr. Phil. Soc., 1921, vol. 20, p. 350) has shown that supplies in chalk and gault districts are at pH7·1–7·2 very constantly, streams rising to pH8·25–8·5. Sea-water is close to pH8·2.

For these more alkaline waters phenol-red would be an unsuitable reagent to detect the unboiled state, as even in it the full red is developed, but phenolphthalein would serve, showing either a colour or an increase in intensity with the boiled water.

Higher limiting values may be obtained with waters containing magnesium salts, since that for magnesium carbonate, on boiling, is close to pH10·0. Sea-water, therefore, may approximate to this, and fresh-water from a small reservoir on Staddon Heights, Plymouth Sound, was by insolation with its naturally occurring algæ brought up to pH9·7.

On cooling, carbon dioxide is re-absorbed by boiled water. This proceeds until the equilibrium with the bicarbonate stage is reached, which is at pH8·37 for saturated calcium bicarbonate. It is slightly lower for water which has been boiled, since it can no longer be saturated with respect to bicarbonate. This stage still gives a good colour with phenol-red, being more than pH8. With water which is naturally at this reaction when unboiled it is advisable to make a direct test to ascertain the time that elapses before the original reaction is regained, but a positive result may always be accepted as proof of boiling.

Since one omission to boil the water may, especially in the tropics, lead to a fatal illness, it is hoped that the use of phenolphthalein, phenol-red, or other suitable indicator may be of use. W. R. G. ATKINS.

Marine Biological Laboratory, Plymouth,
October 31.

Ophion luteus.

THIS fly, one of the larger Ichneumonidæ, appears in my house every year in late summer. Several members of my family have complained of being stung by it, always at night, usually after they had gone to bed in the top story, third above the basement. All doubt about the aggressor was dispelled by a young lady who, when reading in bed, felt a stab on the arm and saw the insect *flagrante delicto*. I am informed on high authority that, while Ophion is one of the few Ichneumonidæ which are known to sting, and while a small, narrow poison sac has been detected in a few species of that immense family, none has been recorded in *Ophion luteus*. But whereas the sting is followed in every instance by considerable inflammation and pain, such as would not be the effect of the mere stab of a needle, it seems almost certain that some irritant is injected into the wound, possibly for the purpose of paralysing the fly's legitimate victim, as in the case of the hunting-wasps.

It puzzles one to divine the purpose of Ophion in attacking sleeping human beings. The weapon employed is the sharp point of the ovipositor. It seems scarcely possible that the intention is that the progeny should be lodged and fed in the body of man, woman, or child. What is normally the creature which Ophion seeks as a harbour for its eggs and larvæ? Is this known? Only once have I seen Ophion in my own bedroom on the first floor. I was reading in bed one night in August last when the fly alighted on the sheet. I regret that instinct prevailed over reason, and I destroyed the creature before the purpose of its visit was revealed.

HERBERT MAXWELL.

Monreith, Whauphill, Wigtownshire, N.B.

Indian Land Mollusca.

I AM sorry that my offer of the Indian operculate land-snails in the collection of the Indian Museum did not reach Sir Arthur Shipley. The offer had the support of the Government of India, which wrote strongly to the India Office as to the unfortunate effect of publishing Mr. Gude's volume without reference to the Indian Museum collection.

I fail, however, to see what the war has to do with the case, and prefer to ignore Sir Arthur Shipley's motive in his attempt to introduce it in his letter in NATURE of October 27 (p. 271). The volume in question was published in 1921, and was, I understand, completed shortly before it was published. I received official information that it was in active progress from the Education Department of the Government of India only in the latter part of last year. My offer was made in reference to this communication through the channel through which I had received it.

N. ANNANDALE.

Royal Societies Club, St. James's Street, S.W.

Curiosities of Nomenclature.

AT Section D of the British Association in two successive years I asked for an explanation of the generic name Calymene, without obtaining it from a roomful of zoologists. On the second occasion I suggested, among other guesses, the remote possibility of a derivation from the Greek word *κεκαλυμμένη*. Since then, while consulting Buckland's Bridgwater Treatise of 1836 for quite another purpose, I have found (vol. 1, p. 371) a footnote on genera of Trilobites giving "Calymene, from *κεκαλυμμένη*, concealed," with Buckland's comment that such names were "devised expressly to denote the obscure nature of the bodies to which they are attached."

Nearly half a century after the date of Brongniart's genus the American carcinologist Packard named a genus Cæcidotæa (if I may trust Scudder's "Nomenclator Zoologicus," vol. 1, p. 52, and vol. 2, p. 47), thus implicitly assigning his blind isopod to the family Idoteidæ in the Valvifera away from its proper place among the Asellidæ. Harger in 1878 spells the name Cœcidotea (U.S. Fish. Comm., part 6, p. 314). Now Dr. Tattersall, with the spelling Cæcidothea (Mem. Asiat. Soc. Bengal, vol. 6, p. 417, 1921), records a new species of the genus from a shallow domestic well in Japan, and observes that "this species is distinguished at once from all the other species of the genus by the presence of distinct, though very small, eyes." Thus we have in Packard's professedly blind Idoteid genus a species which is not an Idoteid and which is not blind. Apart, however, from obvious misnomers, the endeavour to pack a budget of information into a single descriptive name must often fail, because it cannot be foreseen that any character noted in the generic name will prove of more than specific value.

T. R. R. STEBBING.

Ephraim Lodge, The Common, Tunbridge Wells.

The Flight of Thistledown.

PROF. MILES WALKER'S letter in NATURE of October 20 recalls an incident observed during a holiday in the Cheviots in June last which may possibly be of interest in connection with his inquiry.

It was June 24, the hottest day of the year up to that date, and with brilliant sunshine. The air was comparatively still but for the quivering due to the heat, and there was no distinct current. Our attention was arrested by what to all appearance was a dragon-fly hovering 5 or 6 ft. from the ground, and frequently darting a foot or two away. This went on for probably a minute or two, until, in fact, we caught the object for the purpose of finding out what it was. It proved to be a thread of thistledown or something akin to it, and probably an inch and a quarter or more in length.

It was, perhaps, an insignificant occurrence, but the effect was certainly curious and striking. The tiny film very effectually simulated the flight of a dragon-fly, and would, I think, have deceived all but a practised observer. Whatever current there might be was negligible, and the movement—or the stationary quivering attitude—seemed quite independent of it.

W. E. LISHMAN.

73 Osborne Road, Newcastle-upon-Tyne, October 28.

THE rising of plant-down on calm, sunny days as described by Prof. Miles Walker in NATURE of October 20, p. 242, has also been noticed by me occasionally. But could not the upward motion be explained by an upward current of air? We know that the air is usually full of eddies on a hot afternoon. In order to prove that the thistledown moved through, instead of with, the air, it would be necessary to make simultaneous and contiguous measurements of air-motion by means of smoke or of some very special anemometer. It would be interesting to learn if anyone has tried such an experiment.

LEWIS F. RICHARDSON.

Westminster Training College, S.W.1.

Ceratium and Pedalion.

IN recently announcing (NATURE, September 8, p. 42) the finding of Ceratium in this district, I assumed, on the authority of Kent's "Manual of the Infusoria," that the species was *C. furca*. By the kindness of Herr Lektor E. Jörgensen, author of a monograph on the genus Ceratium, who has examined some specimens, I am now enabled to correct the impression unwittingly given by my letter, and to state that the forms found by me are varieties of *Ceratium hirundinella*. My error is, perhaps, a pardonable one in view of the marked differences between the actual organism and Kent's illustration of *C. hirundinella*, and the general correspondence of the specimens found with his description, etc., of *C. furca*.

With regard to *Pedalion mirum*, no information has yet reached me that this rotifer has, during the past thirty-two years, been found at places in Great Britain other than the three mentioned in Hudson and Gosse's work on "The Rotifera."

A. E. HARRIS.

44 Partridge Road, Cardiff, October 20.

Muscular Piezo-electricity?

THE well-known "action current" of muscle can have nothing to do with piezo-electricity, since it may reach its maximum before any mechanical change begins. Nor do I see anything to suggest the occurrence of such electricity in other animal tissues or organs. Mr. Wriothesley Russell (NATURE, October 27, p. 275) might, however, find plants worth investigating for evidence of it. I directed attention sixteen years ago to the association of crystals with electrical changes in *Desmodium gyrans* (Proc. Physiol. Soc., July, 1905), and (according to a short notice in NATURE for August 11, 1921) Steckbeck has shown their association with propagation of stimuli in *Mimosa pudica, Biophytum sensitivum*, and other sensitive plants.

F. BUCHANAN.

University Museum, Oxford, October 31.

Faraday and the Quantum.

By DR. H. STANLEY ALLEN.

IN the third volume of his "Experimental Researches in Electricity" Faraday returns again and yet again to the discussion of lines of magnetic force and of their physical existence. The first paper in the volume bears the suggestive title, "On the Magnetisation of Light and the Illumination of Magnetic Lines of Force." He defines the latter by saying: "By *line of magnetic force*, or *magnetic line of force*, or *magnetic curve*, I mean that exercise of magnetic force which is exerted in the lines usually called magnetic curves, and which equally exist as passing from or to magnetic poles, or forming concentric circles round an electric current." He then goes on to describe his discovery of the magnetic rotation of the plane of polarisation, a phenomenon which Lord Kelvin regarded as a demonstration of the reality of Ampère's explanation of the ultimate nature of magnetism. In the celebrated letter to Richard Phillips, published in the *Philosophical Magazine* for May, 1846, under the title, "Thoughts on Ray-vibrations," Faraday writes:—

> The view which I am so bold as to put forward considers, therefore, radiation as a high species of vibration in the lines of force which are known to connect particles, and also masses, of matter together. It endeavours to dismiss the æther, but not the vibration.

Again in 1852 he says:—

> Having applied the term *line of magnetic force* to an abstract idea, which I believe represents accurately the nature, condition, direction, and comparative amount of the magnetic forces, without reference to any physical condition of the force, I have now applied the term *physical line of force* to include the further idea of their physical nature. The first set of lines I *affirm* upon the evidence of strict experiment. The second set of lines I advocate, chiefly with a view of stating the question of their existence.

This question he regards as "both important and likely to be answered ultimately in the affirmative."

The quantum theory seems to supply the affirmative answer anticipated by Faraday. It has long been recognised that this theory requires a certain atomicity in nature which may be represented either by Planck's constant h, or by some combination of h with other fundamental constants. Planck's constant, which has the value $6{\cdot}558 \times 10^{-27}$ erg sec., may be looked upon as a quantum of action, but it is perhaps simpler to regard it, in accordance with the suggestion of J. W. Nicholson, as an angular momentum. The first indication that the quantum may be essentially magnetic appears in the work of S. B. McLaren, who, in a letter to NATURE (vol. 92, p. 165, 1913), identified the natural unit of angular momentum, $h/2\pi$, used by Bohr, with the angular momentum of the magneton. "Rejecting entirely the idea of magnetic or electric substance, the magneton may be regarded as an inner limiting surface of the æther, formed like an anchor-ring. The tubes of electric induction which terminate on its surface give it an electric charge; the magnetic tubes linked through its aperture make it a permanent magnet." It may be shown from ordinary electrodynamic considerations that the angular momentum of such a system is equal to $Ne/2\pi$, where N is the number of magnetic tubes threading the magneton, and e is the electrostatic charge. According to the quantum theory, the angular momentum must be $nh/2\pi$, where n is an integer, and we may have a one-quantum magneton, a two-quantum magneton, and so on. Identifying these two expressions for the angular momentum, we find

$$Ne = nh,$$

or

$$N = n(h/e).$$

Thus it is seen that the number of tubes of magnetic induction passing through the aperture of the magneton is equal to an integer, n, multiplied by the constant factor h/e. If we suppose that the charge of the magneton is equal to the electron charge $4{\cdot}774 \times 10^{-10}$ E.S.U., we find for h/e, which defines what must be the *fundamental* unit magnetic tube, the value $1{\cdot}374 \times 10^{-17}$ E.S.U. or $4{\cdot}120 \times 10^{-7}$ E.M.U. Consequently one C.G.S. magnetic tube contains nearly two and a half million ($2{\cdot}43 \times 10^{6}$) *quantum tubes*. The electrokinetic energy of the unit tube is $\frac{1}{2}h\nu$, where ν is the frequency of revolution.

A magneton theory of the structure of the atom has been developed with great ingenuity by A. L. Parson, but his theory has not met with acceptance, partly because it employs the notion of a sphere of positive electricity in place of a positive nucleus, but mainly because it is not based on the atomic numbers of Moseley which are now generally accepted as representing accurately the number of electrons in the neutral atom outside the nucleus. Ultimately it may prove necessary to adopt some form of the magneton hypothesis, which seems well adapted to explain magnetic properties, and, by admitting the possibility of stationary electrons, as in the Lewis-Langmuir theory, chemical properties also. But at the present time the results obtained from the Bohr-Sommerfeld theory of spectral frequencies seem to demand electrons which are moving in certain orbits. As pointed out in these columns by Dr. Norman Campbell (NATURE, vol. 106, p. 408, 1920), the difference between the two views may be purely formal.

It is, however, desirable to consider whether

the theory of Bohr, like the magneton theory, points to the existence of discrete magnetic tubes. In 1916 A. L. Bernoulli came to the conclusion that when an electron is in movement in a uniform molecular magnetic field the number of lines of force cut by the radius vector at each revolution is one and the same universal constant. In a paper read before the Royal Society of Edinburgh in November, 1920, the present writer attempted to show that, without any restriction as to the uniformity of the magnetic field, when any number of point charges are revolving round an axis with a common angular velocity, the number of magnetic tubes passing through the stationary circular orbits is equal to an integral number of times the constant h/e. Recently an attempt has been made to extend the result to the more general case of an electron revolving round the positive nucleus in an elliptic orbit. It has been shown independently by Sommerfeld and by W. Wilson that the size and shape of the ellipse depend upon *two* integers n and n', the first introduced by the application of the quantum theory to the angular motion, the second by the application of the theory to the radial motion. The sum of these two integers determines the value of Bohr's W, the total energy of the system with the negative sign prefixed. Making certain plausible assumptions, it appears that the total number of quantum magnetic tubes passing through the elliptic orbit is simply this sum, $n+n'$. This result is obtained by employing the generalised form of the quantum theory first put forward by W. Wilson and used with such success by Sommerfeld and others.

On this theory the mean value of the kinetic energy corresponding to a particular degree of freedom is equal to $\frac{1}{2}nh\nu$, where the mean value is taken over the period, $1/\nu$, corresponding to the co-ordinate under consideration. It is now assumed that this mean energy may be identified with electrokinetic energy. The periodic motion of an electric charge e in an orbit with high frequency ν is regarded as equivalent to a current $e\nu$, and the electrokinetic energy may then be written $\frac{1}{2}\mathrm{N}e\nu$, where N is the number of magnetic tubes passing through the actual orbit, but corresponding to the particular co-ordinate in question. Equating the two expressions for the energy, we find at once

$$\mathrm{N}=n(h/e).$$

It must, of course, be admitted that we do not get out of the equations more than we put into them, so that the assumptions made above virtually imply the existence of discrete tubes of magnetic induction. It is to be noted that we are concerned twice over with the process of taking a time average of a certain quantity, first in evaluating the mean kinetic energy, and secondly in evaluating the electrokinetic energy and assuming the moving charge as equivalent to a current $e\nu$. In the words of Dr. Norman Campbell, "Classical dynamics, it is clear, is only 'statistical'; what are the principles of the elements of the statistical group is the main problem of the physics of the future." The suggestion now made is that the quantum tube is the element referred to.

The physical existence of Faraday's magnetic tubes conforms in many respects to the mode of representation suggested by Sir Joseph Larmor: "One or more electrons constrained to move round a channel would be like an amperean current. It is not unlikely that constraint of this kind will have to be introduced into molecular models to give an account of paramagnetism and ferromagnetism—namely, structure in space or atom involving channels more or less definite for the electrons to circulate in." On the present view such channels or partitions would be provided in consequence of the discrete nature of the tubes of magnetic induction, which would determine the radius of the permissible orbit which an electron describes about the nucleus and account for the property of rigidity.

Sir Oliver Lodge, in a recent paper (*Phil. Mag.*, vol. 41, p. 942, 1921), writes as follows:—"Magnetic lines are always closed curves; there is no known way of generating them; they always pre-exist, though they may be of atomic or molecular magnitude, and in a magnetic field are opened out so as to enclose a perceptible area. This is generally admitted to be the process of magnetisation, and when the magnetism ceases the lines shrink up into infinitesimal, or practically infinitesimal, orbits again. That the *quantum* is associated with these ultimate magnetic units is exceedingly likely."

If we accept the existence of quantum magnetic tubes, many questions of great interest suggest themselves. What happens in the emission or absorption of radiation? Does radiation imply the separation or ejection of a quantum tube from an atomic system, and absorption the incorporation of an external tube? Then, again, how are electrostatic forces to be regarded? Sir Joseph Thomson has pictured a magnetic field as due to the motion of electrostatic tubes. It would, of course, be possible to reverse the process and regard an electrostatic field as set up by moving magnetic tubes. In a suggestive communication to the British Association at Edinburgh Prof. Whittaker discussed the properties of tubes of force in four dimensions, and pointed out that such a tube, which would satisfy all the requirements of the relativity theory, would involve *both* the electric and the magnetic vector. Further, in the four-dimensional world it is action, not energy, which is conserved, so that the field appears open for a direct application of the quantum principle. The experimental physicist may feel somewhat appalled at the prospect of such a solution of his difficulties, but it may yet be necessary to invoke a four-dimensional tube of force as the unit brick from which a universe may be constructed.

The Mineral Industry of India.[1]

By PROF. HENRY LOUIS.

SINCE the year 1903 the Geological Survey of India has published quinquennial records of mineral production upon the lines laid down by the then director, Sir Thomas Holland, and these have supplied an invaluable summary of the development of the mineral resources of India, and, above all, of the industrial progress of the Peninsula. The volume before us, on exactly the same lines as its predecessors, is of especial interest, because it covers a period which may fairly be looked upon as that of the modern industrial awakening of India. Before the war the development of the Indian coalfields had commenced; there was a small but scarcely flourishing iron industry, and a few industries other than native industries were coming into existence. The war, with its attendant disturbance upon the world's shipping, profoundly affected the economic situation in India, and compelled India to produce for herself materials which it had hitherto been found more convenient to import. The majority of the industries thus founded have become stabilised, and among others the foundations for a great iron and steel industry have been laid. It would not be wholly surprising if, within a relatively short period, India were in a position to export steel billets to this country instead of receiving iron and steel from us.

So far as natural resources are concerned, an iron industry depends essentially upon the production of coal and iron ore. During the period under review the production of coal rose from about 16½ million tons in 1914 to 20¾ million tons in 1918, thus increasing by nearly 25 per cent. The values at the pit's mouth given in these records depend to a great extent upon the position of the collieries and the demand for coal in their immediate vicinity; furthermore, during 1917 and 1918 the prices were fixed by the Coal Controller on behalf of the Government, and, therefore, have no statistical value. The prices for 1916 are, therefore, the most recent prices that can be considered here. The two provinces of Bengal and of Bihar and Orissa are the most important coal producers, having during the period under discussion produced more than 90 per cent. of the total output, and the average value per ton of coal in these two provinces in 1916 was 4*s*. 2*d*. at the pit's mouth (taking the rupee at 1*s*. 4*d*.). There appear to be enormous quantities of high-class iron ores in the two provinces above-named, averaging above 60 per cent. of iron, and containing for the most part moderate proportions of phosphorus with relatively little silica; the value of the ore, even of this high quality, was in 1918 1*s*. 8*d*. per ton. When these prices are compared with prices at home it will be seen that they are only about one-eighth of corresponding prices in this country, and when it is further borne in mind that Indian labour is plentiful, is still cheap in spite of its increases in recent years, and is intelligent, docile and reasonably efficient, it must be fairly obvious that we in the old country can scarcely hope to compete with India as an iron-producer.

An examination of the figures respecting coal production brings out the importance of the Indian coal output; it is greater than that of any other British Dependency, and its rate of development appears to be exceeded only by that of Japan; it is interesting to note that in 1885 India and Japan each produced 1,294,000 tons, whilst in 1918 India produced 20,722,000 and Japan 27,579,000 tons. The efficiency of the Indian coal-miner appears to be relatively low, mainly because, on account of the cheapness of the labour, much work is done by hand in India which is done by mechanical means elsewhere; in the Indian coalfields the system of transporting coal in baskets carried on the head is not yet wholly extinct. Nevertheless, the output per person employed during the period under review was about 108 tons per person, or just about half of what it is in this country. The most important feature, however, is that the output per worker employed below ground has increased, and is steadily increasing, this being the opposite to what we unfortunately find to be the case in this country. Concurrently with this improvement we find that the accident death-rate is decreasing; during the quinquennial period here discussed the death-rate per thousand persons employed was 1·14, whilst during the corresponding period in the United Kingdom it was 1·3.

The report also directs attention to the fact that coal-cutting machinery is on the increase in India; that the Indian collieries are admirably adapted for the employment of electricity underground; that several important schemes for electric supply to the coalfields are in contemplation; and that the Indian workman is naturally highly adaptable to the handling of electrical machinery; and it is predicted that the result of the more extended use of electricity will be to cheapen costs still further. Competition with Indian coal will thus be rendered still more difficult so far as we are concerned, and the prediction that Indian coal will before long supply Egypt, and may even compete with us in the Mediterranean, appears by no means impossible of accomplishment.

In other respects the mineral industry of India appears to be in a thoroughly successful condition, and shows signs of a steady advance, the value of the output having more than doubled itself in the last ten years. Attention may be directed to the fact that India is now manufacturing its own ferro-manganese, and that it is hoped before long to produce sulphuric acid from indigenous materials —namely, from the zinc concentrates produced by the Burma Corporation at Bawdwin.

[1] Records of the Geological Survey of India. Vol. 52., April, 1921 "Quinquennial Review of the Mineral Production of India for the Years 1914–18." By the Director and Senior Officers of the Geological Survey of India.

Liquid Air Explosives.

AN Order in Council (1921, No. 1194) has been issued exempting explosives made by impregnating absorbent carbonaceous material with liquid air or oxygen from that provision of the Explosives Act which requires the manufacture of explosives to be carried out in licensed premises. This Order will, therefore, enable free competition between explosives of the usual type and mixtures of liquid oxygen with a fuel that can be made on the spot shortly before firing.

Liquid oxygen explosives originated in Germany, but before the war had no great vogue. During the war they were used on a fairly large scale by the Germans in non-gaseous coal mines, in iron mines, and for the destruction of machinery in French steel plants. This development was occasioned by the need for conserving Germany's supply of nitrates for the manufacture of military explosives.

The increasing cost of explosives and the improved methods of obtaining liquid oxygen make the problem of producing explosives by the simple method of saturating materials like wood-meal with liquid oxygen an attractive one. The explosives so produced also present certain advantages, especially as regards freedom from danger in transport, storage, and handling, but they have certain inherent disadvantages: thus, the rapid evaporation of the liquid oxygen necessitates rapid firing and so limits the number of shots that can be fired in one blast; it is necessary to have a liquefying plant close at hand; and the explosive cannot be used in fiery mines.

The plant required for liquefaction must be capable of turning out a product containing at least 85 per cent. of liquid oxygen. This is conveyed in Dewar vessels to the proximity of the rock face, where it is poured over a paper cartridge containing carbonaceous matter of different kinds, such as carbonised cork, or wood-meal, with or without the addition of petroleum. The impregnation of this cartridge with the liquid oxygen is carried out in a cylindrical vacuum-jacketed vessel, care being taken that the impregnated cartridge contains sufficient oxygen to ensure the total combustion of the carbonaceous filling and of its paper envelope. The impregnated cartridges are then pushed into the bore hole, where they are detonated by means of the usual detonator, or in some cases simply by a gunpowder fuze. According to another method the cartridges are impregnated in the bore-hole itself. The violence of this explosive is comparable with that of the more intense blasting agents, but much depends upon the manipulative skill of the workers.

For industrial purposes, since the war, there has been a general reversion to explosives based on nitrates, but it is understood that liquid air explosives are still used in Germany to a limited extent, and that experiments are being made with them in certain French Departments. Their investigation is also being carried on by the United States Bureau of Mines, which has issued a preliminary bulletin on the subject.

Obituary.

Prof. F. A. Bainbridge, F.R.S.

PROF. FRANCIS ARTHUR BAINBRIDGE passed away on October 27. His friends knew he was not well enough to carry on his usual busy life of teaching and research, but none foresaw that his life would be suddenly cut short by heart failure. He was only forty-seven years old and in the prime of his career. Our deep sympathy goes out to his widow and little daughter.

Prof. Bainbridge had for years been a man of poor physique, and it was a wonder to his friends how, in spite of frequent attacks of illness, he contrived to do so much useful work. He was modest and retiring, but his catholic interest in scientific work and in things in general made him a delightful and lovable companion. He was a skilful experimenter, a clear writer, and an excellent teacher. Such men we can ill spare. The book ("Essentials of Physiology") he wrote with the late Prof. Menzies is highly esteemed, and illustrates to the full the power he had of interesting his readers and of making crooked paths straight.

Prof. Bainbridge was born at Stockton-on-Tees, educated at the Leys School, and then at Trinity College, Cambridge. His medical studies were carried out at St. Bartholomew's, and after a brilliant academic career he filled several minor posts in that hospital. His early researches were carried out at University College. Among the positions he held were British Medical Research Scholar, demonstrator in pharmacology at St. Bartholomew's, Gordon lecturer on pathology at Guy's, Jenner Memorial student and assistant bacteriologist at the Lister Institute, later the professorship of physiology at Newcastle (1911), and finally, 1915, he returned to his old school, St. Bartholomew's, as university professor of physiology. At the outbreak of war he at once offered his services, received a temporary commission in the R.A.M.C., and had charge of a military hospital at Newcastle; he worked also on the action of poison gases at Millbank, and gave lectures on that subject in cadet training schools throughout the country; but the stress of work was too great, and his health broke down, so that he had to resign his commission. His devotion to duty of all kinds made him an

example to us all. His honours included the F.R.C.P. and F.R.S.

Instead of attempting to give a list of Prof. Bainbridge's published researches, I will quote from a document drawn up by Prof. Starling which admirably gives the main features of his work; he has allowed me to use it:—

"A very large proportion of Prof. Bainbridge's work represents important additions to knowledge which have found a permanent place in the record of scientific discovery. In pathology his most important work was in the differentiation of the different types of para-typhoid bacilli, a study which has been carried very far in later years. It was, however, on the physiological side that his work was of most importance. In his researches on lymph formation he took up the question of the tissue lymph and defined for the first time the part played in lymph formation by the metabolism of cells. Working on the sub-maxillary gland and the liver, he pointed out the defects in the secretory theory and showed that all the results obtained might be explained as due to the production of metabolites in the cells and the consequent rise of osmotic tension in the tissue fluid which had the effect of attracting fluid from the blood vessels and adding to the lymph flow from the part. The question of the mechanism of urinary secretion was one which occupied him frequently through his scientific career. His earliest work, carried out with Beddard, consisted in a repetition of Nussbaum's experiments, avoiding many of the sources of fallacy which these contained. At first he was inclined to ascribe a secretory function both to glomeruli and to tubules, but later, in experiments carried out at Newcastle, he was led to adopt Cushny's view, in the support of which he brought forward many new and ingenious experiments. His work with Evans on the functions of the mammalian kidney fed with blood from a heart–lung preparation was, unfortunately, only in the nature of a preliminary communication, but the method promises to be of considerable value for the elucidation of many problems connected with urinary secretion. His work on the gall-bladder with Dale was a useful contribution to a department of physiology in which knowledge is very deficient.

"Most interest, however, attaches to his latest work on the circulation, and especially to the discovery of the relationship which holds between pressure on the venous side of the heart and the rate of the heart-beat. Many attempts had been made to explain the acceleration of the pulse which occurs in exercise. The pace-maker itself is unaffected by the pressure in the auricular cavity, though a quickening of the pulse is one of the methods adopted by the organism for enabling the heart to deal with the greater inflow of blood into this organ which accompanies muscular exercise. Bainbridge showed that any rise of pressure on the venous side of the heart caused a quickening of the beat, partly by inhibition of the vagal tone, partly by reflex excitation of the accelerator mechanism. This condition is the converse of that which is expressed as Marey's law, a rise of pressure on the ventricular side tending to cause reflex slowing of the heart, and it is therefore described as 'Bainbridge's law.' The review of the whole subject of the physiology of exercise, which he undertook in writing a comprehensive monograph on the subject, suggested many new problems for work on the circulation, and he was making plans to attack these problems, partly alone, partly in conjunction with other physiologists, when his work was brought to a sudden and premature close; but he was happy in his work and in the planning of new researches, and he would be content that others should build on the foundations which he has laid down."

Prof. Bainbridge married in 1905 Hilda Winifred, daughter of the Rev. E. Thornton Smith. In his wife he found a companion keenly interested in his work, who, by her constant co-operation and care, enabled him to utilise his talents to the full, in spite of the disability of ill-health from which he suffered. W. D. H.

Dr. W. S. Bruce.

THE untimely death on October 29, at the age of fifty-four, of William Speirs Bruce removes a leading oceanographer and the foremost British authority of his time on Polar regions. From the age of twenty-five Bruce had devoted practically his whole life to the exploration of Polar lands and seas, and had to his credit no less than twelve Arctic and two Antarctic expeditions. On the eve of completing his medical course at Edinburgh he sailed for the Antarctic in the Dundee whaler *Balaena* in 1892. The visit of this and other whalers was of course a commercial venture, and though Bruce was mainly occupied in assisting the crew in sealing, he found time to make many valuable observations in the north-western part of the Weddell Sea, the first scientific observations made in those regions for half a century. Returning home the following year, he became an assistant in the *Challenger* office, and later was in charge of the observatory on the summit of Ben Nevis until 1896, when at a few hours' notice he sailed in the *Windward* to Franz Josef Land with the Jackson-Harmsworth Polar expedition. For a year he assisted in the survey of the archipelago and made valuable collections, and he was present at the historic meeting with Dr. F. Nansen on his return from the Polar ocean. In 1898 Bruce sailed with Major A. Coats to Novaya Zemlya, Kolguev, and Hope Island, and later in the same summer with the Prince of Monaco to Spitsbergen. This was the first of many cruises with the Prince of Monaco, and laid the foundation of Bruce's wide and authoritative knowledge of Spitsbergen and its natural history.

Since his return from the Antarctic Bruce had

never ceased urging the renewal of Antarctic exploration. The difficulties in awakening interest and raising the funds were great, especially for a man of Bruce's sensitive and retiring nature; but he was dauntless, as ever, in the pursuit of his aim. Largely through the liberality of the late Mr. James Coats, of Paisley, and Major Andrew Coats, but also by public subscription in Scotland, sufficient funds were raised, and in 1902 the Scottish National Antarctic Expedition sailed in the *Scotia* for the Weddell Sea, returning in 1904. The expedition, like all with which Bruce was associated, had no record-breaking aims except in the amount of scientific work to be accomplished. It devoted chief attention to oceanography, zoology, and meteorology. From all points of view it was a great success. By the unexpected discovery of Coats Land in lat. 74° S., some half-million square miles were added to the area of Antarctica. More than 10,000 miles of ocean were sounded and investigated, and collections were made in depths down to 3,000 fathoms. With the single exception of the *Challenger*, the *Scotia* collections have never been equalled in size and importance.

The expedition founded a meteorological station at the South Orkneys, which has since been maintained by the Argentine Government. Later attempts to organise a new Antarctic expedition failed for want of funds; but Bruce devoted himself to publishing the scientific results of the *Scotia* expedition and the foundation of the Scottish Oceanographical Laboratory in which he hoped to see the nucleus of a great oceanographical institute in Edinburgh. He also paid repeated visits to Spitsbergen, exploring and mapping in detail Prince Charles Foreland and taking a leading part in the economic development of the archipelago.

Bruce received the gold medal of the Royal Scottish Geographical Society (1904), the patron's medal of the Royal Geographical Society (1910), the Neill prize and gold medal of the Royal Society of Edinburgh (1911–13), and the David Livingstone centenary gold medal awarded by the American Geographical Society (1920). He was an honorary LL.D. of Aberdeen (1907), and was nominated by the Prince of Monaco a member of the committee of the Oceanographical Institute of Paris. His publications include "Polar Exploration" (1911), "The Weddell Sea: An Historical Retrospect" (1917), and many zoological and oceanographical papers in transactions of various societies and in the *Scotia* results.

No man could give himself more wholly to his work than Bruce did, or ask for less reward: publicity in any form was distasteful to him. He shrank from a life lived in public, but he was tireless in advancing Polar exploration even when he himself could not share in the expedition concerned. As a leader his indomitable spirit, invariable thoughtfulness for others, and cheery comradeship endeared him to all who served with him. His last instructions contain an appeal for further Antarctic work in their directions that after cremation his ashes are, if possible, to be scattered in the South Atlantic ocean about long. 10–15° E. in a high southern latitude, a region where exploration is much needed.

R. N. R. B.

PROF. F. E. ARMSTRONG.

THE death of Prof. F. E. Armstrong, which occurred after a very brief illness on October 28, deprives the University of Sheffield and the mining industry of a man who had already rendered great services to both and would have rendered many more had he lived. Born in 1879, the son of the Rev. R. A. Armstrong, a Liverpool Unitarian minister, Francis Edwin Armstrong was educated at Giggleswick School and University College, Liverpool. After spending some time in an electrical engineering firm, he became an articled pupil at the Tinsley Park Colliery, Sheffield, and afterwards assistant to Mr. J. H. W. Laverick, first in Derbyshire, and then in Warwickshire. In 1906 he went to Mexico to manage the collieries of the late Sir Ernest Cassel, and also visited and reported on mines in British Columbia. He rejoined Mr. Laverick in Sheffield, and in 1913, when acting as engineer to the Askern Coal and Iron Co., Doncaster, he was appointed to the chair of mining in the University of Sheffield, a position which he was exceptionally well qualified to fill, from his wide practical experience and theoretical knowledge. He was an admirable teacher, and had a great influence among mining men of the district in which he taught. In 1914 he volunteered for service with the Friends' Ambulance Unit, and took his motor-car to France, where he did useful work. In 1917 and 1918 he was head of the Labour Section of the Coal Mines Department of the Board of Trade, and in 1919 was appointed a member of the committee on miners' lamps. His work on this subject was of great value to the committee, and was still proceeding.

Kindly and generous, with an ardent love of justice, Prof. Armstrong was keenly interested in social, political, and religious questions, quietly and unobtrusively taking an active part in many movements of reform. He worked unselfishly, without thought of reward, and might have played an important part in the regeneration of the coal-mining industry. His early and unexpected death came as a shock to his colleagues and students, whose affection and esteem he had won by his kindness and high moral character.

C. H. D.

THE death is announced, on November 4, at thirty-seven years of age, of MR. HERMAN SLOOG, honorary secretary of the Groupe Inter-Universitaire Franco-Britannique, the Société des Ingénieurs Civils de France, and the Office National des Universités et Ecoles Françaises.

Notes.

THE DUKE OF YORK visited Sheffield on November 4 and inspected the works of Messrs. Hadfield, Ltd., and of Messrs. Joseph Rodgers and Sons, in addition to taking part in several functions in the city. In the course of the ceremony of opening a new power station for the electricity department of the Corporation of Sheffield, his Royal Highness referred to the intention of the Corporation to extend the system of electric lighting to the homes of the working people, and went on to say:—"The enormous power station which I am about to open, with all its mechanical and scientific devices, graphically illustrates the last word in economy, and must effectively cheapen production, improve trade, and thereby lessen unemployment. If, in order to meet competition in the markets of the world, manufacturers are forced to economise, it is, in my view, a better policy to seek a solution of the problem in scientific research than merely to fall back upon a curtailment of wages. In the future the prosperity of the manual worker depends so largely upon scientific development in our industries that I would appeal to our younger generation, in whose advancement I have so deep an interest, to let this truth sink well into their minds. If Britain is to maintain her proud position among the nations of the world, they must contribute their quota of science, as in the past generation was done by such men as Kelvin, Watt, Stephenson, and Hopkinson." It is appropriate that such words should be spoken in Sheffield, the principal industry of which, the manufacture of steels of high quality, owes more than most to scientific research. The manufacturers of the city have recognised this fact in their continued support of their University, which has been closely associated with the scientific advancement of industry; and at the present moment, when industry is faced with such a host of economic difficulties, the lesson is more than ever needed, and the wise warning of the Duke of York deserves the attention of all who look for an escape from the present condition of stagnation.

THE forthcoming Royal Society High Altitude Expedition to Peru sails in the third week of this month. The expedition proposes to study the adaptation of man to life at or above the altitude of 14,000 ft. As compared with other localities in which this type of work has been carried out, Peru possesses certain advantages:—(1) Being near the equator, the effects of altitude are less complicated by those of cold than in higher latitudes. (2) The Central Railway of Peru, the highest standard-gauge railway in the world, ascends the Andes to an altitude of 15,885 ft. (3) A mining population lives and works in localities situated above 14,000 and 16,000 ft., or even higher. It is alleged, for example, that the porters at the town of Cerro de Pasco, in the Andes, raise the ores 600 ft. from the mines by carrying loads of 160 lb. of mineral many times in the day. There is probably no other population which carries on such heavy work in so rare an atmosphere. Experimental methods for the study of the circulatory and respiratory systems have advanced so much within the last ten or twenty years that the time seems ripe for their application to the extraordinarily interesting problems which life at high altitudes presents. Donations towards the expenses of the expedition have been received from the following:—The Royal Society, the Harvard Medical School, the Carnegie Fund, the Moray Fund, the University of Toronto, the Rockefeller Institute, the Presbyterian Hospital, New York, Sir Peter Mackie, and Sir Robert Hadfield.

ON Wednesday, November 2, the Secretary of State for War (Sir L. Worthington Evans) unveiled in the examination hall of the Pharmaceutical Society, 17 Bloomsbury Square, a bronze relief portrait of the late Lt.-Col. E. F. Harrison, who played such a prominent and important part in combating the poison gas used by the Germans. The hall, lined with a guard of honour furnished by the University of London O.T.C., was filled with a distinguished company of pharmacists, representatives of the War Office, officers in uniform, and graduates of the University in their academical robes. The platform was occupied by the president of the society (Mr. E. I. Neathercoat), the president of the British Pharmaceutical Conference (Prof. H. G. Greenish), and the Secretary of State for War (Sir L. Worthington Evans). The president alluded to Harrison's scientific career, and paid a well-deserved tribute to his energy and ability. In 1915, at the age of forty-seven, he joined the Sportsmen's Battalion as a private, but soon after the first gas attack he was transferred to the Royal Engineers and became a leading spirit in the Anti-Gas Department. His work culminated in the production of the small box respirator, which proved so effective in counteracting the poison gas that no fewer than 22,000,000 were made, Harrison being finally appointed Controller of Chemical Warfare. The Secretary of State for War acknowledged in an admirable speech the debt that the War Office owed to pharmacy for placing at their disposal the benefits of its knowledge and the marvellous results of its investigations, and on behalf of every officer and man in the Army paid a tribute of respect and gratitude to Harrison, by whose devotion and self-sacrifice thousands of lives had been saved. Science had turned the poisoned arrows of the savages into the poison gas of civilisation, and might devise weapons more deadly still, so that the soldier's need for science grew greater every day. Sir L. Worthington Evans then unveiled the memorial, the guard of honour presenting arms, and the buglers of the Coldstream Guards sounding the "Last Post"—an impressive and touching finale to a ceremony marked throughout by reverent dignity and grace.

THE Radio New York Central Station, which is the most powerful transmitting station yet built, was opened on November 5 by President Harding sending a message to all the large radio stations in the world. After pointing out that such an achievement marks

an epoch in the scientific development of radio communication, he said that the earnest hope of the American nation is that the peace which blesses their own land may presently become the fortune of all lands and peoples. The station belongs to the Radio Corporation of New York, which already possesses several stations capable of carrying Transatlantic traffic, notably with Great Britain, Norway, Germany, and France. These stations are said to be capable of transmitting automatically at speeds of fifty words per minute. In the new station six separate antennæ mounted on towers 400 ft. high radiate from a common centre. They are each equipped with their own 200-kw. alternator. When completed, the space occupied by the station and its radiating antennæ will be 10 square miles. It is said to be capable of transmitting at 100 words per minute. It can transmit and receive messages in all directions simultaneously. President Harding's radiogram was received by stations in Great Britain, Norway, France, Germany, and Australia, and doubtless by many others. According to the *Times*, the letters WQK are the call-letters of the new station. The frequency of the alternating-current supply is about 19,000. The wave-length used, one of the thirty-nine which have been allotted internationally to the United States, is 16,465 metres.

SECTION 1 (5) of the Safeguarding of Industries Act provided for the appointment of a referee by the Lord Chancellor to decide complaints against the inclusion or exclusion of articles from the Board of Trade's published lists of articles under the key industry part of the Act. The *Times* of October 27 contained an announcement that Mr. Cyril Atkinson, K.C., has been appointed. A day later it was announced that our Customs authorities had given notice that no further consignments of goods coming within the scope of the Act should be sent from abroad until further notice, as their staffs were inadequate to deal with the goods already lying at the docks awaiting examination. The worst prognostications of the opponents of the Key Industries Bill are thus justified. Leaving out of consideration altogether the utility of the measure, it cannot be denied that it was rushed through the Commons, where practically all amendments were brushed aside, and treated as a Money Bill, thus preventing discussion in the Lords. It is already unpopular among many manufacturers and traders, and has roused a strong feeling of resentment among scientific workers. Many complaints have been received by the Board of Trade, so that Mr. Atkinson will probably be kept busy. A deputation representing the British Association of Chemists, which was received at the Board of Trade on October 26 by Mr. P. W. Ashley, took exception to the inclusion under the Act of some hundreds of chemical products that are not made in this country at the present time, and to many other products that are deemed by the association to be outside the scope of the schedule of the Act.

THE Mount Everest Expedition returned to Darjeeling on October 25. Col. Howard Bury's last despatch to the *Times* gives an account of the journey from the base at Kharta, which occupied twenty days. The march from Kharta was up the Arun and Kaichu Valleys to Lumeh. Thence the route chosen was *via* the Quiok (Cuckoo) Pass and the Gadompa rope bridge over the Arun to Tinki Dzong and Khampa Dzong, which was reached on October 11. Messrs. Heron, Wheeler, and Raeburn then went south over the Serpola Pass and the Teesta Valley through Sikkim to Darjeeling, but, owing to the lack of transport on that route, Col. Bury and Mr. Wollaston had to take the main caravan back *via* Linghi and Phari. Heavy weather and much snow were encountered on this part of the route, but Darjeeling was reached without mishap. The season's work has been very satisfactory, and only bad weather prevented the climbers reaching a higher altitude on the possible route to the summit of Mount Everest which was found on the north-east. The coolies were a great success and gave no trouble. Many of them suffered no ill-effects at high altitudes, and have volunteered for next year's expedition. The surveyors under Major Morshead have mapped an area of more than 13,000 square miles, and Major Wheeler made a photographic survey of the whole of the Everest group. Important geological and biological collections have been made by Dr. Heron and Mr. Wollaston. The latter is also bringing back a large collection of seeds from the valleys round Mount Everest.

AT the meeting of the Royal Geographical Society on Monday the president announced that the members of the Mount Everest Expedition are now on their way home, and will be received at a meeting of the society in the Queen's Hall on December 20. Messrs. Mallory and Bullock, who climbed one of the north-eastern buttresses of Mount Everest to within some 6000 ft. of the summit, are satisfied that the actual configuration of the mountain should not prevent the top being reached. Next year's expedition is planned to leave Darjeeling about March 21 in order that May and June may be devoted to the climb, as these appear to be the best months. Col. Howard Bury is unable to resume the leadership next year, but some of the other members of this year's expedition will go out again. The climbing party is to consist of six men. Many of the Himalayan coolies employed this year have volunteered to return. The total cost of the expedition so far, excluding what the Government of India may have expended in survey, is about 5000*l*. The president paid a tribute to the Tibetan authorities for the great assistance they have shown to the expedition.

THE annual Huxley lecture of the Royal Anthropological Institute for the present year will be delivered by Mr. H. Balfour in the lecture-room of the Royal Society on Tuesday, November 29, at 8.30. The title will be "The Archer's Bow in the Homeric Poems."

THE following have been elected officers of the Cambridge Philosophical Society for the session 1921–22:—*President:* Prof. Seward. *Vice-Presidents:* Mr. C. T. R. Wilson, Dr. E. H. Griffiths, and Prof. Newall. *Treasurer:* Mr. F. A. Potts. *Secretaries:* Mr. H. H. Brindley, Prof. Baker, and Mr. F. W. Aston. *New Members of the Council:* Mr. H. H.

Thomas, Mr. R. H. Fowler, Mr. E. Cunningham, and Mr. T. C. Nicholas.

EVEN if the Oppau explosion had been heard in this country, the fact would have been very difficult to prove, and it is therefore not surprising that the Air Ministry should announce a negative result to their inquiries. The explosion took place at 6.32 a.m. (G.M.T.) on September 21, and should have been heard in England between 7 and 7.30 a.m. Only four out of forty-eight correspondents refer definitely to this time, "and there is little to indicate that the noises they mention differed from others which could not have been due to the explosion."

A SUM of 250,000*l.* has been allocated to forestry from the Unemployment Fund. The Forestry Commissioners who will administer this sum wish to direct attention to the grants that are offered, the object being the relief of the unemployed and the promotion of afforestation. As regards local authorities, a free grant of a fixed sum (approximately 60 per cent. of the labour bill) is obtainable for every acre planted. Provision has been made for assistance towards meeting unemployment by means of free grants to woodland owners who provide work for unemployed. In ordinary cases 3*l.* per acre is the sum available, but where the areas are covered with scrub the grant may amount to 5*l.* in all. Inquiries regarding grants, and offers of land for planting, should be addressed, for England and Wales, to the Assistant Commissioner, Forestry Commission, 1 Whitehall, London, S.W.1, and as regards Scotland, to the Assistant Commissioner, Forestry Commission, 25 Drumsheugh Gardens, Edinburgh.

ON November 2 the Natural History Museum Staff Association held a very successful and largely attended scientific reunion—the third and last for the current year—in the board room of the museum by permission of the Trustees. Many interesting specimens recently acquired by the museum were exhibited, the more important of them being a series of marine invertebrates from Japan collected and presented by Mr. Alan V. Insole, which included many rare and remarkable forms; the fœtal African elephant, the third known in point of smallness, presented by Mr. H. A. Hopwood; a series of minerals and rocks from the Simplon Tunnel, including fine crystals of purple anhydrite, presented by Mr. F. N. Ashcroft; and fossils, mostly ammonites, from a single bed of marl in Lower Lias at Charmouth. Lord Rothschild showed examples of melanic aberration in Lepidoptera, and considerable interest was taken in Mr. M. Maxwell's remarkable photographic enlargements of East African big game, especially those showing giraffes in full gallop. Dr. F. A. Bather gave a short lecture on "Tubular Quartzites and Sandstones."

A REPORT of the inaugural meeting of the Institution of Rubber Industry held on October 19 at the Royal Society of Arts appears in the *India-Rubber Journal* for October 22. Sir Henry Wickham, who in 1870 brought the first Hevea seeds from the banks of the Amazon to Kew, was the guest of the evening. After the address of the president, Mr. J. H. C. Brooking, Mr. H. Rogers, manager of Messrs. James Lyne Hancock, Ltd., gave an interesting review of the history of rubber manufacture. The firm mentioned was founded by the great English pioneer of the rubber industry, Thomas Hancock (1786–1865). The Indians of America were the first to use caoutchouc, and from them we get the term "India," while the word "rubber" is due to Priestley's use of the substance in 1770 for erasing pencil-marks. Up to 1840 only unvulcanised rubber was used. The credit of first producing rubber which would withstand changes in temperature without getting soft and sticky belongs to Charles Goodyer, an American, who died in 1861. In 1843 Hancock took out his patent for vulcanising by sulphur alone. This was twenty years after Macintosh had patented his method of rendering fabric impervious to rain and wind. Hancock was assisted in his development of the manufacture of rubber by his four brothers, one of whom, Walter Hancock (1799–1852), was a pioneer of steam road-cars.

IN the issue of *Discovery* for November Mr. F. W. Hall describes the excavations which have disclosed the buried Roman city of Timgad, or Thamugadi, as its founder called it, in Algeria, about a hundred miles from the northern coast and little more than twenty from the nearest French settlement at Batna. It can be compared only with Pompeii, but in some ways Timgad is even more Roman. Pompeii grew out of an old Oscan town, and its architects never had a free hand in laying it out, but Timgad, founded by the Emperor Trajan in A.D. 100, was systematically planned as a fortified frontier town to resist the attacks of the wild tribes of the south. It is built in the form of a Roman camp, a true square with an area of about 30 acres. But it is not quite symmetrical, and the avenue from east to west conforms to the alignment of the great road from Lambaesis to Theveste. Its roads, drainage system, and public baths were constructed with the efficiency which marks all Roman work; a fine system of public markets met the wants of trade, and a public library promoted intellectual culture. Its end came when in 533 Belisarius destroyed Vandal power by his victory near Carthage and, in alarm, the Berber tribes swept down from their mountains and destroyed it. Excavations by the French Government began in 1880, and have continued to the present time, throwing "a flood of light upon Roman life and history by disclosing the authentic features of a daughter city of Imperial Rome."

A LONG account, accompanied by a sketch-map, of the work of the Canadian Arctic Expedition of 1913–18 is given in the *Geographical Journal* for October by Mr. V. Stefansson. Apart from the anthropological and biological observations, which are not yet ready for publication, the main results include the rectification of the coast-line of Banks Island, Prince Albert Land, and Ellef Ringnes Island, and the discovery of two new islands in the Gustav Adolf Sea and one between Isachsen Island and Cape Thomas Hubbard. These islands have not yet received names. By a journey northward over the ice of the Beaufort Sea Mr. S. Storkersen proved the non-existence of the

mythical Keenan Land by getting a sounding of more than 3000 metres on its site. It is of interest to note that during his journey Mr. Storkersen and his companions drifted on an ice-floe more than 450 miles during six months, but were unable to discover any definite current in the southern part of the Beaufort Sea; the direction of drift varied with the local winds. This absence of definite current precludes the feasibility of exploring the Beaufort Sea by an ice-bound drifting ship. On the other hand, Mr. Stefansson hopes on his next expedition to explore it by means of small sledge-parties travelling over the sea-ice and depending solely on seals for food.

"COULD the Drought of 1921 have been Forecasted?" is the subject of an article by Mr. C. E. P. Brooks in the *Meteorological Magazine* for September. The author suggests that while the abnormal weather of the past spring and summer in Europe is fresh in everyone's memory, it is an interesting exercise to apply the principles of the *Réseau Mondial*, dealing with the world's meteorology, and by constructing charts of pressure and temperature deviations from normal to attempt a prompt explanation. Charts have been constructed for the months of December, 1920, to June, 1921, comprising North America, the Atlantic, Europe, India, and much of Africa. For the period of the drought extending from February to June anticyclonic conditions prevailed generally over Europe and North America. The pressure attained its maximum near Valencia, where it was 6·2 mb. above the normal, whilst at Spitsbergen the deficiency was 6·5 mb. Temperature was slightly below the normal in the south, but much above the normal in the north. Most of the district covered by the chart suffered from drought. Especial mention is made of Exner's principle, which asserts that low pressure over the Arctic basin in winter is normally associated with high pressure over the Atlantic west and south-west of Ireland and with high temperature over the British Isles in the same season. The author extends Exner's discovery, and is of opinion that some idea of the rainfall of the spring and early summer in the British Isles may probably be obtained from a study of the pressures and temperatures of the Arctic basin during the preceding months. Low Arctic pressure is said to cause low British rainfall, and high Arctic pressure high British rainfall.

PROF. H. H. DIXON, of Trinity College, Dublin, has devised a handy method for the measurement of transparent microscopical specimens situated on the stage of any microscope possessing a reasonably good substage condenser. A small transparent screen, divided by sets of thin black lines into small squares, is held by a suitable adjustable folding stand so as to intercept normally the light falling on the plane mirror of the microscope. By a slight motion of the substage focussing adjustment the image (formed by the substage condenser) of the lines on the screen is brought into focus at the same time as the image of the specimen seen in the microscope. Of course the size of the intervals between the first images of the lines has to be measured once and for all, either accurately by means of a stage micrometer slide of the usual type, or approximately by means of some object of known dimensions. In order to keep the screen in a known position in successive measurements the top of it usually rests against the stage. The makers claim that the regular sub-division of the field by the images of the lines is of assistance in making accurate drawings of microscopic objects. As the result of tests, we can say that the arrangement fulfils all that is claimed for it. It is called the "Ghost Micrometer," and is made by Mr. G. H. Mason, 5 and 6 Dame Street, Dublin.

THE various theories of atomic structure current at the present time agree in ascribing the spectrum emitted by an atom to the electrons. If the electrons emit radiation independently of each other the separation in a magnetic field of the components of a spectral line should be proportional to the field, and deviations from this law may be taken as indication of some kind of coupling between the electrons. At the suggestion of Prof. Nagaoka, of the University of Tokyo, Mr. Y. Takahashi has measured the separations of a number of iron lines produced between nickel steel electrodes by the spark of an induction coil, in the field of an electromagnet capable of going to 37,000 gauss. The separation was observed by a Hilger echelon with a constant deviation spectroscope behind it. For the nine strong violet lines seven were found to give separations proportional to the field, while two gave larger separations in stronger fields. Of the weaker lines some give larger separations than usual, which are not proportional to the field. Both facts point to the existence of some mutual influence of the electrons on each other.

DURING the war a considerable area of Northern France and Belgium was entirely re-mapped, largely from aeroplane photographs taken by a camera rigidly fixed to the underside of the aeroplane. The method of using these photographs for map production is described in *Engineering* for October 21, in an illustrated article by Mr. R. B. Unwin. If the aeroplane were slightly tilted when the photograph was taken the result is a distorted view of the ground instead of a true map. In mapping from aeroplane photographs it is therefore necessary to form a "framework" on which to hang the photographs. The framework consists of a number of points, the exact position of which on the ground must be known, and they must be such as can be identified on the photographs. The original trigonometrical survey points were used as primary points, and as these were not sufficiently close to form a complete framework, intermediate points were fixed. These intermediate points were determined by the use of a plane table behind our lines, or if behind the enemies' lines, were deduced from the aeroplane photographs. At least four points are necessary, which were set out on a compilation diagram, and a tracing made and attached to a board which could be tilted. Lines were drawn on the negative joining the corresponding stations, and an enlarging camera was employed to project an image of the negative on the tracing. The board was then tilted until the image of the lines

fitted those on the tracing, thus eliminating the effect of the tilt of the aeroplane. When sensitised paper was substituted for the tracing, the print obtained was free from distortion, and was used for plotting the map.

MESSRS. MACMILLAN AND CO., LTD., are issuing immediately vol. 1 of "The Palace of Minos," a comparative account of the successive stages of the early Cretan civilisation, as illustrated by the discoveries at Knossos, by Sir Arthur Evans, price six guineas net. The volume deals with the Neolithic and Early and Middle Minoan Ages. It will be found to be an indispensable preliminary to the study of Mycenæan Greece, the culture of which is the outgrowth of the earlier Minoan stages of Crete.

SIR WILLIAM TILDEN and Prof. J. C. Philip are editing for Messrs. G. Routledge and Sons, Ltd., a new series entitled "The Twentieth-Century Chemistry," the aim of which is the production of readable and interesting books which, without being exhaustive monographs, will furnish advanced students of chemistry with a complete survey of the present state of knowledge and opinion in each branch of the science.

MESSRS. G. BELL AND SONS, LTD., are to publish at an early date a translation, by L. Taverner, of "An Introduction to the Study of Metallography and Macrography," by L. Guillet and A. Portevin. The work will contain an introduction by Prof. H. C. H. Carpenter.

Our Astronomical Column.

THE FRENCH WIRELESS TIME-SIGNALS.—These signals are now so widely used by astronomers for time-determination that it is well to direct attention to an alteration which is announced in *Circulaire No.* 4, *Bureau Internationale de l'Heure*. The signals have hitherto been sent out at definite mean times; but the time is determined by meridian transits of block-stars, which necessitates the use of a sidereal clock, the error of which must be determined, and that of the mean-time clock inferred by comparison. It is now announced that, in order to avoid this transformation, beats 1 and 300 of the rhythmic signals will be sent according to Greenwich sidereal time, and the interval between the beats will be 49/50 of a sidereal second (roughly 44/45 of a mean second, instead of 49/50 as formerly).

A detailed list of the mean times of the signals, both old and new, and of the nature of the emissions used in each, is given in the circular; there are several changes. It is clear that a signal cannot be sent both at a constant mean time and a constant sidereal time: a different sidereal minute will be concerned every day. For some time after the change the signals will be preceded by the words "sidereal time," but it is not clearly explained how the actual sidereal minutes will be made known.

The new system will come into use on November 15, and will be experimented on up to the time of the meeting of the International Astronomical Union, when the question will be further discussed in the light of the experience gained.

PROPER MOTIONS OF LONG-PERIOD VARIABLE STARS.—*Astronomical Journal*, Nos. 784 and 791, contain determinations of the proper motions of thirty-seven long-period variable stars made at Mount Holyoke College by Misses Young, Farnsworth, and Jenkins. Two series of plates were taken, the time-interval ranging from nine to nineteen years. The proper motions are referred to the faint background stars, which were previously tested with a stereo-comparator, to exclude any that showed appreciable motion.

There is thus a certain amount of systematic shift in each field, arising from the solar motion, but it is unlikely to exceed 0·01″ per annum in any case. The deduced annual motion for each star is:—RR Androm., 0·060″; Y Androm., 0·021″; T Camelop., 0·016″; V Orion., 0·028″; Y Monoc., 0·031″; R Gemin., 0·022″; T Gemin., 0·029″; U Cancri, 0·019″; S Hydræ, 0·037″; T Hydræ, 0·021″; T Virg., 0·011″; S Sagittar., 0·013″; χ Cyg., 0·038″; Z Cyg., 0·018″; W Capric., 0·027″; T Delph., 0·023″; RR Aquar., 0·052″; S Ariet., 0·091″; R Ceti, 0·022″; V Gem., 0·040″; RU Herc., 0·006″; S Scorp., 0·037″; W Ophi., 0·030″; RS Herc., 0·042″; SY Cyg., 0·030″; Z Aquil., 0·023″; S Peg., 0·066″; S Aurig., 0·042″; U Puppis, 0·039″; V Leo., 0·023″; U Lib., 0·056″; U Serp., 0·049″; Y Aquar., 0·038″; T Capric., 0·014″; U Aquar., 0·020″; and R Peg., 0·038″.

The mean value is 0·032″, implying distances of the order of 100 parsecs. The sun at this distance would have magnitude 10·5, so that the stars in question have absolute magnitude (at maximum) somewhat brighter than the sun's. They are, therefore, not extreme dwarfs, but neither are they extreme giants of the type of Betelgeux. The only long-period variable with a considerable proper motion is Mira Ceti, for which Boss's value is 0·237″.

THE LAST GLACIAL EPOCH.—The Ice ages have an astronomical aspect, so that reference may be made in this column to a paper by Mr. C. E. P. Brooks (Quarterly Journal R. Met. Soc., July, 1921) which assigns the date 30,000 to 18,000 B.C. for the last great glaciation in North-West Europe (Ireland, Scotland, Scandinavia, and the Baltic). Some remains of glaciation continued until 6000 B.C.; after some intermediate phases the date 1800 B.C. to A.D. 300 is assigned to the Peat-bog Phase, when the climate was cooler and moister than at present. Thes changes are attributed chiefly to alterations of elevation; increased elevation has the double effect of producing glaciation on land and of closing the Straits of Dover and other channels for the warm currents from the Atlantic. Mr. Brooks also assigns considerable weight to the 1800-year cycle in tide-generating force announced by Mr. O. Pettersson. But it is very doubtful whether this cycle will explain any appreciable climatic changes. It does not mean that all the tides are higher at one of these 1800-year maxima, but merely implies that there are a few tides in the year very slightly in excess of those at other epochs, just as there are total solar eclipses of maximum duration at something like the same interval.

Since Mr. Brooks gives evidence of an approach to simultaneity in climatic changes in Europe and America, some cosmical cause is indicated; but the suggestion of a long-period variation in solar output (analogous to the short-period variations announced by Mr. Abbot) seems more hopeful than the tidal cycle.

The Structure of Adularia and Moonstone.

By Dr. A. E. H. Tutton, F.R.S.

A NEW and very promising scientific journal—Science Reports of the Tôhoku Imperial University, Sendai, Japan, vol 1, No. 1—printed in English at Tokio, has recently been issued (June, 1921). It contains the results of an investigation, commenced at Cambridge, by Mr. S. Kozu, who was assisted later in Japan by Y. Endo and M. Suzuki, on the X-ray analysis of adularia felspar from the St. Gotthard and the moonstone of Ceylon and Korea, and on the influence of temperature on their atomic arrangements. Adularia and moonstone are supposed by mineralogists to be solid solutions of varying proportions of orthoclase (monoclinic potash felspar, $KAlSi_3O_8$), albite (triclinic soda felspar, $NaAlSi_3O_8$), and anorthite (triclinic lime felspar, $CaAl_2Si_2O_8$), the moonstone of Ceylon being regarded as a variety of adularia exhibiting the property known as "schillerization," the exhibition of a pearly, sub-metallic, or bronze-like lustre. But determinations made in Cambridge of the refractive indices and optic axial angles of the monoclinic felspars by Mr. Kozu, the results of which were communicated to the Mineralogical Society in 1916, showed that these constants are much higher for moonstone than for adularia. This is due to different molecular structure corresponding to a different chemical composition, the optical constants always increasing with the presence of soda, of which moonstone contains nearly three times as much as adularia.

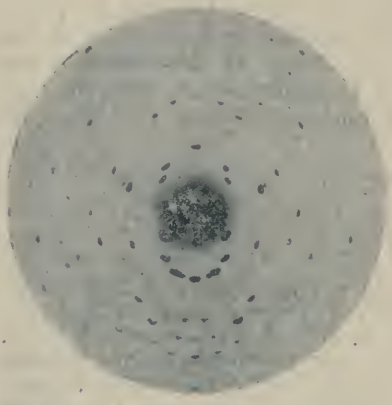

Fig. 1.—Adularia from St. Gotthard, plate parallel (001).

Fig. 2.—Moonstone from Ceylon, plate parallel (001).

When the crystals were submitted to X-ray analysis by the Laue radiographic method, and the radiograms compared, very remarkable differences were observed. In the case of adularia all the spots were arranged on single circles of the stereographic projection of the radiogram, or, in the case of the actual photograph, on ellipses, passing through the centre of the figure, while those of moonstone were in double circles, as will be clear from the two reproductions of the photographs themselves in Figs. 1 and 2, and of their stereographic projections in Figs. 3 and 4.

This indicates that adularia consists of a single kind of space-lattice and forms a homogeneous solid solution, while moonstone consists of two kinds of space-lattice, the atoms being distributed in two different arrangements. The two components of moonstone are not, however, pure potash felspar and pure soda felspar, but two kinds of solid solutions, both having monoclinic symmetry.

On heating the crystals a most interesting thing happens. Nothing occurs up to 500° C., but then the circles of spots corresponding to the structure richer in soda begin to decrease in intensity and also continuously approach in position those of the arrangement richer in potash, until at about 1060° C. the

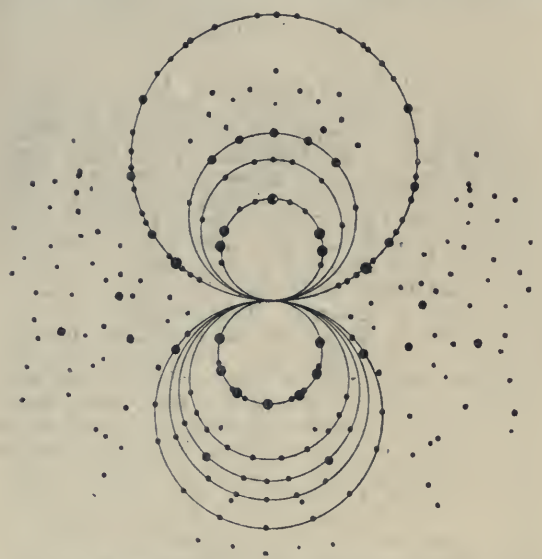

Fig. 3.—Stereographic projection of Laue spots of adularia (001).

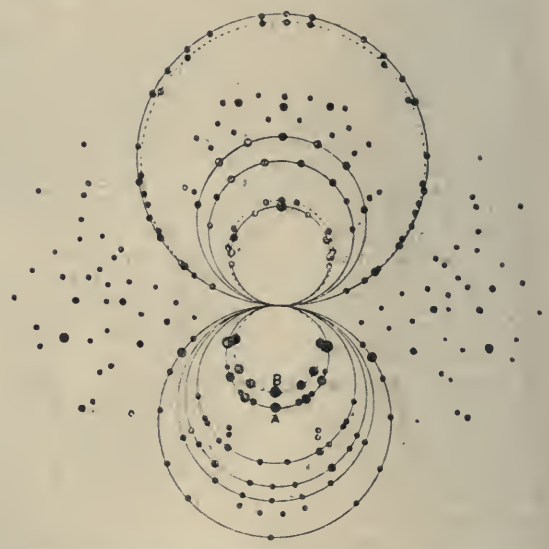

Fig. 4.—Stereographic projection of Laue spots of moonstone (001).

two series of circles overlie one another exactly and become identical with those of the latter arrangement and similar to those of adularia. At 1190° C. melting begins, and the spots disappear. Moreover, as the temperature approached 1000° C. the schillerization disappeared. Hence the schillerization of moonstone is due to the fact that interference of ordinary light-rays is produced by the presence of the two different space-lattices corresponding to the two arrangements.

Similar investigation of the moonstone found ten years ago in Korea led to analogous and confirmatory results. This moonstone proves to be more sodic and calcic than the Cingalese variety, and the two sets of spots which its radiograms exhibit, corresponding to two distinct sets of space-lattice net-planes, are given by plates parallel to the side pinakoid faces, whereas in the case of the moonstone from Ceylon they were afforded by plates parallel to the basal plane. On heating the crystal the schillerization disappears, and the two systems of spots become coincident at a temperature of 790° C., very much below the melting-point of the crystal, which lies between 1100° and 1200° C.

These Japanese investigators would thus appear to have proved that in the cases of moonstone of Ceylon and Korea, the beautiful schillerization appearance is not due to the presence of inclusions and lucunæ, as formerly believed, but to the existence of two distinct, yet closely similar, space-lattices, which are so arranged with respect to each other as to cause the rays of ordinary light to interfere. It is very gratifying that the work commenced by Mr. Kozu in Cambridge has led to such interesting and important results.

Tissue Metabolism.

Oxidation and Oxidative Mechanisms in Living Tissues.

AT a joint meeting of the Sections of Chemistry and Physiology during the recent meeting of the British Association at Edinburgh a discussion on the above subject was opened by Prof. F. G. Hopkins, who commenced by pointing out that the essential task of biochemistry is dynamic. The task of investigation is difficult because the living structure is easily destroyed. In spite of this obstacle considerable progress has been made by various methods.

In the oxidation of fatty acids it is now recognised that the oxidation takes place in the β-position. Knoop investigated this problem by loading the fatty acid molecule with a non-oxidisable group, namely, a phenyl group. The side chain of fatty acid is oxidised so that all the substances administered reappeared as two substances. All those with an odd number of carbon atoms were oxidised to benzoic acid which was found in the urine combined with glycine as hippuric acid, whilst all those with an even number of carbon atoms were oxidised to phenylacetic acid, which was found combined with glycine as phenylaceturic acid. This result suggested that two carbon atoms were removed at each stage, thus there was no indication that by removal of one carbon atom the series with odd or even carbon atoms could be changed from one to the other.

Embden perfused fatty acids through the surviving liver, and found that all those with an even number of carbon atoms passed through the four-carbon stage whilst those with an odd number of carbon atoms did not pass through that stage. This, again, indicated that a single carbon atom was never removed, so that the odd and even carbon chains were not interconvertible.

The fate of the two carbon atoms that are split off has not yet been determined. It is interesting to remember that large quantities of material are dealt with in this manner, and that more than three thousand tons of fatty acid are oxidised daily in the human body in this country.

It is probable that carbohydrates are not oxidised directly, but that hexoses are converted into lactic acid. In the study of this problem isolated muscles are useful because the functional condition of muscle can be tested by its ability to contract. The change from hexose to lactic acid is probably associated with the presence of hexose phosphate, a fact which links up the metabolism of higher organisms with the fermentation of sugar by yeast, in which hexose phosphate is an important intermediate stage.

Surviving muscle, in anaerobic condition, loses carbohydrate with the formation of lactic acid; when oxygen is readmitted the lactic acid disappears. The removal of lactic acid is not due entirely to oxidation, but about one quarter of the acid is oxidised, and three quarters are reconverted into glycogen. Associated with these changes it can be shown that muscle contraction can be divided into at least two stages, one in which no oxidation occurs, and a later stage in which recovery is associated with the disappearance of oxygen.

The fate of proteins is that they are resolved into their constituent amino-acids, and the oxidation of these individual acids must be investigated. The result of disease, and of the administration of drugs, is to cause the appearance of intermediate products from which one learns that the amine group is removed by oxidation giving rise to keto-acids. The behaviour of acids with special groups in them furnishes further information. In dogs kynurenic acid is the end product of oxidation of tryptophane. If indole lactic acid is administered it is found to be toxic, and it does not give rise to kynurenic acid. The corresponding keto-acid is not toxic, and gives rise to kynurenic acid, showing that in this case the amine group is removed from tryptophane by oxidation giving rise to the keto-acid, and not by hydrolysis giving indole lactic acid as the intermediate substance.

It is the outstanding feature of oxidation in living organisms that they can take in molecular oxygen and combust material at a temperature of not more than 38° C. which are not combusted by molecular oxygen at moderate temperatures outside the body. All cells contain autoxidisable substances with the apparent formation of peroxides. Oxidising enzymes are found in many cells, some of which, however, need the presence of a peroxide whilst others apparently can form their own peroxide. In plants the peroxide-forming substances are probably something of a catechol nature. The oxidases are usually studied by the use of colour-forming indicators.

Hydrolytic oxidation and reduction may also occur. For instance, milk does not act by itself on acetaldehyde or on methylene-blue, but in a mixture of these two milk causes an oxidation of acetaldehyde and reduction of methylene-blue. This is analogous to the Cannizzaro reaction, where two molecules of benzaldehyde react, one being reduced to benzyl alcohol and the other oxidised to benzoic acid. For this type of reaction it is necessary to have an activation of hydrogen with a hydrogen acceptor, so that the oxygen of water is set free to produce oxidation of some other substance.

Prof. Hopkins has lately isolated an autoxidisable substance from a number of tissues. It is a dipeptide containing glutamic acid and cystein. This peptide exists in two forms, one oxidised, in which two molecules of dipeptide unite through their sulphur atoms to form a double molecule. The double molecule is a hydrogen acceptor whilst the single molecule sulphhydrate is a hydrogen donator. This reversible reaction allows the dipeptide to act as an intermediate substance in tissue oxidation, so that the rate of the double reaction may be twenty times as fast as the rate of oxidation in the absence of the dipeptide. The reduction of the disulphide to sulphhydrate requires the presence of a specific tissue enzyme.

The nature of the hydrogen donators in the tissue is not determined, but lactic acid is one of them, with the formation of pyruvic acid.

In his concluding remarks Prof. Hopkins appealed to younger chemists to take an interest in the problems of metabolism as their solution requires chemically trained minds. He pointed out that the reactions which take place in living tissues are not different from those which take place in the laboratory, but that they take place under different conditions. In living tissues catalysts play an important part, and chemical science will not be complete until the nature of catalytic reactions are explained.

A number of speakers took part in the debate, and the participation of chemists in biological work was urged by several speakers.

PHOTOSYNTHESIS.

Following the discussion on oxidative mechanisms, a paper by Prof. E. C. C. Baly, Prof. I. M. Heilbron, and Mr. W. F. Barker was read on the synthesis of formaldehyde and carbohydrates from carbon dioxide and water. This study was the outcome of an investigation into the combination of hydrogen and chlorine under the influence of light. It was found that the rate was not proportional to the intensity of light. It was suggested that the infra-red oscillation frequencies of hydrochloric acid contained some frequencies characteristic of chlorine, thus the first-formed hydrochloric acid could autocatalytically activate more chlorine.

Carbon dioxide absorbs short wave-lengths in the ultra-violet, but it is not affected by visible light. By passing a current of carbon dioxide through water exposed to ultra-violet light it is possible to show the formation of formaldehyde. The previous experiments of Moore and Webster required the presence of an inorganic catalyst, but their failure to show formaldehyde in the absence of the catalyst was probably due to too rapid polymerisation of the formaldehyde. The stirring effect of carbon dioxide passing through the fluid allows some of the formaldehyde to escape polymerisation.

The visible rays require a photocatalyst with an infra-red vibration of the same frequency as the carbon dioxide. Chlorophyll absorbs visible light, and as it forms a compound with carbon dioxide it can pass on the trapped energy to the carbon dioxide. Malachite-green, methyl-orange, and other dyes which can combine with carbon dioxide likewise catalyse carbon dioxide, so that formaldehyde is formed by the action of visible light.

Similarly polymerisation of formaldehyde requires a coloured substance which can unite with formaldehyde.

The photo-equilibrium of

hexose ⟶ carbon dioxide
↖ ↗
formaldehyde

is difficult to demonstrate because formaldehyde is oxidised to formic acid by hydrogen peroxide, but the reactions of carbon dioxide ⟶ formaldehyde and formaldehyde ⟶ sugar are both catalysed by pigments in visible light.

Formaldehyde is not detectable in plants because of its rapid removal. The chlorophyll absorbs the rays which decompose sugar, hence the above equilibrium becomes

hexose carbon dioxide
↖ ↗
formaldehyde

Melanesian Land-tenure.

AT a meeting of the Royal Anthropological Institute held on October 11 Dr. W. H. R. Rivers, president, gave an account of the Melanesian system of land-tenure. He described the nature of the ownership of land in two patrilineal societies in Melanesia, Ambrim in the New Hebrides, and Eddystone Island in the Solomons, and showed that its essentially communistic character agreed with the account given by Codrington of the land-tenure of the matrilineal parts of the archipelago. This close agreement, contrasting with the great diversity of other aspects of Melanesian culture, was held to indicate that the communal ownership of land was an early, though not necessarily the earliest, feature of Melanesian society which has been little affected by the many influences to which the general diversity is due.

The fact that chiefs in Melanesia have no special privilege in relation to land, and may even be wholly landless, supports this conclusion, for there is reason to believe that the present chiefs of Melanesia are the descendants of relatively late immigrants.

The ownership of trees, apart from that of the land on which they grow, and the different laws of inheritance to which the two kinds of property are subject were described, as well as the customs by which the produce of certain trees is assigned to individual use by means of religious ceremonial. These customs were explained as concessions made to immigrants by the indigenous owners of the soil, who, while denying to strangers all rights in the land itself, allowed them to own trees and transmit them to their children. It was suggested that in some cases, and especially when individual ownership or usufruct has a religious sanction, the trees concerned may have been introduced by immigrants. The whole situation in relation to the ownership of trees and land was regarded as a characteristic instance of a compromise formation by which was solved a conflict between the communistic sentiments of an indigenous people and the individualism of immigrants.

University and Educational Intelligence.

BRISTOL.—The Imperial Tobacco Co. (Great Britain and Ireland), Ltd., Bristol, has contributed the sum of 10,000*l*., and Mr. C. H. Baker the sum of 5000*l*., to the fund now being raised for the development of the University.

CAMBRIDGE.—The University has presented an address to Dr. G. D. Liveing, St. John's College, formerly professor of chemistry, to commemorate the fact that he has kept by residence every term in the University for the last seventy-five years. Dr. Liveing graduated as eleventh wrangler in 1850, and was top of the First Class in the Natural Sciences Tripos in 1851, the first year in which the examination was held. He became fellow of St. John's College in 1853, and professor of chemistry in 1861.

Mr. J. M. Wordie has been elected to a fellowship at St. John's College. Mr. Wordie accompanied Sir Ernest Shackleton to Antarctica as geologist, and recently was a member of a scientific excursion to Jan Mayen Island, where he climbed the Beerenberg.

Prof. A. C. Seward is lecturing on Greenland to the Cambridge Philosophical Society on Monday, November 14.

Statutes have now been approved for the research degrees of M.Sc. and M.Litt. These involve only two years' post-graduate residence as against three years required for the Ph.D.

LEEDS.—On October 25 the University joined in the sexcentenary commemoration of Dante's death by a lecture delivered in the Great Hall by Prof. Grant on "Dante's Conception of History." Prof. Grant laid stress on the interest which Dante took in the historic past of mankind so far as he knew it—a characteristic which marked him off from the other great poets of Europe. His relation to pagan antiquity was examined and the true character of the Italian renaissance was deduced from it. The University sent a letter written in Latin to the citizens of Bologna on the eve of the celebrations expressing homage to the memory of Dante.

On November 3 the new education wing was opened by the Chancellor of the University, the Duke of Devonshire. In the evening a conversazione was held in the main buildings of the University. The proceedings commenced with a reception in the Great Hall by the Chancellor, the Pro-Chancellor (Mr. E. G. Arnold) and Mrs. Arnold, and the Vice-Chancellor (Sir Michael Sadler) and Lady Sadler, after which the visitors, numbering about a thousand, dispersed along three routes to inspect the numerous experiments and exhibits displayed in the various departments of the University. In addition to ordinary departmental displays, there were two special exhibitions, one of which was devoted to "Bacteria and Human Welfare." A large number of microscopic preparations were on view illustrating the bearing of bacteriology on agriculture, horticulture, the leather industries, human pathology, and public health. The other display, described as the Yorkshire Studies Exhibition, was the outcome of a joint contribution of several departments of the University, including geology, agriculture, geography, and history. Both naturalistic and humanistic studies were well illustrated, and contained much matter for guidance for present and future research on the region.

IN connection with the Institute of Chemistry a lecture on "Modern Applications of Chemistry to Crop Production" will be delivered by Dr. E. J. Russell in the Chemical Lecture Theatre of King's College, Strand, at 8 o'clock on Monday, November 14. The lecture is open to all fellows, associates, and registered students of the institute and to all chemical students in recognised colleges.

NOTWITHSTANDING the financial embarrassments of modern universities, to which repeated allusion has been made in these columns, the Lords Commissioners of the Treasury in their review of the estimated expenditure for 1922–23 have decided to reduce the annual grant-in-aid of university education from 1,500,000*l.* to 1,200,000*l.* It appears that the latter sum represents the amount of grant already allocated to the various university institutions in the form of *annual* grant. Accordingly, this sum will not be reduced, but other and additional grants which may have been made, amounting in the aggregate to 300,000*l.*, will be discontinued. This is an unfortunate decision, and one which will be viewed with dismay by those who have to finance the modern university. It will undoubtedly react adversely upon the efficiency of the universities, and, in particular, lead to a further delay in putting the salaries of university teachers upon a sound footing.

THE Royal Technical College, Glasgow, has now completed the one hundred and twenty-fifth year of its existence, and the annual report recently issued by the governors illustrates clearly the impetus which whole-time study has received during the past few years. The total number of students in attendance during the past year was 5646, practically the same as for the previous session, but the proportion between day and evening students has changed considerably. Moreover, the day students, who numbered 1290—an increase of 155—contributed roughly two-thirds of the total student-hours registered in the college, as against a little more than half the total for the previous session. Chemistry, with an enrolment of 1218 day and 478 evening students, heads the list of student enrolments by subjects, but mathematics, natural philosophy, mechanics, and mechanical and electrical engineering have each attracted more than a thousand entries. The financial situation is not so satisfactory, the year's working showing a deficit of nearly 1000*l.* Of the available income of 70,697*l.*, more than a quarter comes from students' fees, about one-sixth from donations and endowments, and a similar fraction from the Treasury, which includes a non-recurrent grant of 4000*l.* The balance was provided by grants from the Scottish Education Department. Noteworthy events of the past session were the establishment of a school of pharmacy in the college, and an anonymous gift founding a research scholarship of the annual value of 200*l.*, mainly for engineers and metallurgists.

RELIEF work among students in Austria was started by the Friends Relief Mission early in 1920, and the acute distress of many Austrian professors and lecturers was the occasion for the formation of a Vienna University Relief Committee, for which funds were subscribed by British universities. In July of the same year the Imperial War Relief Fund agreed to undertake the appeals to universities in the British Isles on behalf of the professors and students of Central Europe, and an inter-university committee was formed. Its appeal met with a generous response—some 22,000*l.* being subscribed in cash and gifts in kind. It is thought, however, that the appeal has not reached many of the senior members and graduates of our universities, and pamphlets descriptive of conditions among professors and lecturers in Austria have been issued in the hope of stimulating further generosity. During the first few months of this year free rations of food were supplied to a number of professors of Vienna University and officials of the State museums and their dependents, several hopelessly inadequate pensions were augmented by monthly grants of 1*l.*, and grants were also made to enable the more needy to purchase clothing. In order to continue this work, a sum of 10,000*l.* is estimated as necessary for the year 1921–22, at the end of which period relief work will probably come to an end. Subscriptions should be marked "Professors" and sent to the Organising Secretary, Universities Committee, Imperial War Relief Fund, Fishmongers' Hall, E.C.4; gifts in kind and worn clothing marked "Universities," should be sent to the Friends Emergency and War Victims Relief Committee, 5 New Street Hill, E.C.4, and notification given to the Organising Secretary; gifts of books should be sent to Mr. B. M. Headicar, Universities Library for Central Europe, London School of Economics, Clare Market, W.C.2.

Calendar of Scientific Pioneers.

November 10, 1832. Johann Gaspar Spurzheim died.—The disciple of and fellow-worker with Gall, the founder of cerebral physiology, Spurzheim studied medicine in Vienna, and with Gall published "Anatomie et Physiologie du Système nerveux en générale et du Cerveau en particulier."

November 10, 1852. Gideon Algernon Mantell died.—Especially successful in the discovery and description of fossils of the South Downs, Mantell was a surgeon by profession and practised at Lewes, Brighton, and Clapham. His collections are preserved in the British Museum and his drawings in Yale University.

November 12, 1793. Jean Sylvain Bailly died.—Originally intended for a painter, an acquaintance with Lacaille led Bailly into astronomical studies, and in 1763 he became a member of the Paris Academy of Sciences, establishing his reputation by a memoir on Jupiter's satellites. Later on he published a history of astronomy. A promoter of the French Revolution, the day of the storming of the Bastille, July 14, 1789, he was chosen mayor of Paris. His action at the Champs de Mars, July 17, 1791, lost him his popularity, and two years later he perished beneath the guillotine.

November 13, 1802. André Michaux died.—Acquiring a taste for botany from his father, Michaux studied under Jussieu, and travelled in Spain, Persia, and North America. He died at Madagascar while on a journey to Australia. The genus Michauxia is named after him.

November 14, 1716. Gottfried Wilhelm Leibniz died.—Born in Leipzig towards the end of the Thirty Years' War, Leibniz was the son of a professor of moral philosophy. During diplomatic missions to France and England he became acquainted with Huygens, Boyle, and Newton, and it was through Huygens he was led to study geometry. In 1676 he became librarian to the Hanoverian family, a post he held until his death. Equally eminent as a philosopher and a mathematician, he is recognised as one of the discoverers of the infinitesimal calculus, and the inventor of the accepted notation. The inauguration of the Berlin Academy of Sciences was due to him, and he became its first president.

November 15, 1630. Johann Kepler died.—Immortalised by his discovery of the laws of planetary motion, Kepler "may be said to have constructed the edifice of the universe." Taught astronomy at Tübingen by Maestlin, in 1593 he succeeded Stadt as professor of that subject at Gratz, and in 1600 joined Tycho Brahe at Prague, after Tycho's death becoming Court mathematician to the Emperor Rudolph II. From 1612 to 1629 he was at Linz, and the following year he died at Ratisbon. Applying the diverse talents of a singularly gifted mind to the study of Tycho's observations, Kepler in 1609 discovered the first two of the laws which bear his name, and in 1618 the third. His "Astronomia Nova" is among the classics of science. At his death his manuscripts were purchased by Hevelius, and are now preserved at Pulkowa observatory.

November 16, 1915. Raphael Meldola died.—For thirty years professor of chemistry at the Technical College, Finsbury, Meldola was especially known for his work on the chemistry of colouring matters. The friend of Darwin, he was also a naturalist, translated Weismann's "Theory of Descent," and was president of the Entomological Society. E. C. S.

Societies and Academies.

LONDON.

Royal Society, November 3.—Prof. C. S. Sherrington, president, in the chair.—T. R. **Merton**: The spectra of lead isotopes. Comparison of the wave-lengths of five lines in the spectra of ordinary lead and lead from Australian carnotite shows differences which are not constant, but vary for the different lines. The difference in wave-length observed for the principal line, $\lambda=4058$ Å., is about two hundred times as great as that expected on theoretical grounds.—G. I. **Taylor**: Experiments with rotating fluids. Methods are described by which experiments on spheres, cylinders, and vortex rings moving through rotating fluids can be projected in a lantern and instantaneous photographs taken. If any small motion be given to a rotating fluid, the resulting flow will be such that concentrated masses of coloured liquid should be drawn out into thin films, parallel to the axis of rotation. Photographs taken by a camera placed vertically above a rotating basin of water show that the liquid moves in this way.—L. **Bairstow**, Miss B. M. **Cave**, and Miss E. D. **Lang**: The two-dimensional slow motion of viscous fluids. In its restricted form the equation of motion of a viscous fluid is $\nabla^4\psi=0$, where ψ is Stokes's stream function. If the molecular rotation in the fluid be defined by $\xi\equiv\nabla^2\psi$, the equation of motion may be expressed alternatively as $\nabla^2\xi=0$. The equation $\nabla^4\psi=0$ is transformed by means of Green's theorem to a form in which the only unknown is the distribution of the ξ doublets on the boundaries. The strengths of the doublets are found by solving the resulting integral equation. An example shows the motion of fluid past a circular cylinder in an infinite parallel-walled channel. If d be the diameter of the cylinder, ρ the density of the fluid, ν the kinematic coefficient of viscosity, and U the velocity of the fluid in the centre of the channel at infinity, then, when the width of the channel is $5d$, the resistance per unit length of cylinder is $R=7{\cdot}10\rho\nu d\mathrm{U}$. The value of $\mathrm{U}d/\nu$ to which this formula applies is not to exceed 0·2.—H. C. H. **Carpenter** and Constance **Elam**: The production of single crystals of aluminium and their tensile properties. The parallel portion of the test pieces of the sheet was 4 in. × 1 in. × 0·125 in., consisting of about 1,687,000. The conversion of this area into a single crystal involved heat treatment for six hours at 550° C., tensile stress of 2·4 tons per square inch, producing an average elongation of 1·6 per cent. on 3 in., and final heat treatment beginning at 450° and extending up to 600° C. On an average, one test piece in four produces a single crystal over its parallel portion, which frequently grows up into the shoulders of the test piece. The tenacity of single crystals varied from 2·8 to 4·08 tons per sq. in., while the extension on 3 in. varied from 34 to 86 per cent., according to the orientation of crystal relative to stress. Five types of specimens were recognised. Stress tests of test pieces consisting of two and three crystals show the strengthening influence of one crystal upon another. Experiments on round bars resulted in the production of single crystals in the parallel portion of bars 0·564 and 0·798 in. in diameter. The total volumes of the crystals were more than 1 cb.in., and more than 2 cb.in. respectively. The tensile properties were determined, and in every case a wedge-shaped fracture was produced, the bar diminishing principally in one dimension only. Remarkable twinning effects were observed in certain cases.—C. V. **Raman** and B. **Ray**: The transmission colours of sulphur suspensions. When a few drops of sulphuric acid are added to a dilute solution of sodium thiosulphate and a precipi-

tate of sulphur gradually forms in the liquid, the suspension becomes practically opaque to the shorter wave-lengths first and the longer wave-lengths later, and afterwards regains its transparency partially, the shorter wave-lengths re-appearing first and later the longer wave-lengths. A theoretical explanation is offered.—E. F. **Burton** and Miss E. **Bishop**: The law of distribution of particles in colloidal solution.

PARIS.

Academy of Sciences, October 24.—M. Georges Lemoine in the chair.—P. **Painlevé**: Classical mechanics and the theory of relativity. A vigorous criticism of the Einstein theory, and especially of the assumptions contained in the ds^2 equation.—E. **Picard**: Some remarks on the theory of relativity.—A. **Haller** and Mme. P. **Ramart**: The reduction products of dimethylcampholamide. This amide, reduced with sodium and absolute alcohol, instead of furnishing the alcohol with more or less of the corresponding amine, gives only small quantities of the base, together with a substance not identified. The latter, when distilled, gives water and the nitrile of dimethylcampholic acid.—A. **Lebeuf**: Observation of the partial eclipse of the moon of October 16, 1921, made at the Besançon Observatory.—L. **Fabry**: Observation of the eclipse of the moon of October 16, 1921, made at Marseilles.—G. **Julia**: The permutability of rational substitutions.—T. **Varapoulos**: Increasing functions.—P. **Fatou**: A group of algebraic substitutions.—J. **Andrade**: Spiral cylinders and the hypothesis called *des techniciens*. A discussion of the theory of the balance spring of the chronometer.—M. **Riabouchinski**: The equations of motion of a fluid referred to mobile axes.—D. **Eydoux**: The necessity of the existence of a vortex vector in the movements of liquids, when there is a variation of energy along the trajectories of the various particles.—E. **Belot**: Contribution to the study of the formation of double stars, multiple stars, clusters, and planetary nebulæ.—A. **Danjon**: Photometric study of the eclipse of the moon of October 16–17, 1921. Two hundred and twenty-three observations were made at Strasbourg under good conditions, the object being to determine the curve of brightness (e) of the moon at the interior of the umbra, and of the penumbra as a function of the distance to the axis of the core. Sufficient results are given to fix the form of the curve: the theoretical values of log e in the penumbra are in good agreement with the observed values.—J. **Guillaume** and H. **Grouiller**: Observations during the eclipse of the moon of October 16, 1921, made at the Lyons Observatory.—M. **Holweck**: Critical potentials relative to the K and L_1 discontinuities of the absorption of aluminium. New determination of Planck's constant, h. The values obtained are 1560 volts for the critical potential K, 64 volts for L_1, and for h, $6{\cdot}55 \times 10^{-27}$.—P. **Pascal**: Magnetochemical research on constitution in mineral chemistry. The sulphur acids. The method of magnetic analysis has been used with success in the study of the constitution of organic compounds, and has now been employed in the examination of sulphur compounds. From the examination of sulphones, sulphonates, sulphates, hydroxylamine sulphonates, sulphites, and thiosulphates, some conclusions are drawn, the most important of which is that the magnetic properties of the sulphites are inconsistent with the unsymmetrical sulphonic constitution.—M. **Travers**: A new method for the estimation of silica. The silica is converted into potassium fluosilicate, and this titrated with standard alkali. The method has the advantage over the one in common use that neither the presence of alumina nor fluorides interfere.—M. **Grandmougin**: The identity of the dibromoanthraquinone which served for the synthesis of alizarine. Graebe and Liebermann, in their historical synthesis of alizarine, made use of a dibromoanthraquinone, the exact constitution of which has not up to now been fixed. The four homonuclear dibromoanthraquinones, the 1 : 2, 1 : 3, 1 : 4, and 2 : 3 isomers were prepared, and the last (2 : 3) found to be identical with the Graebe and Liebermann material.—Ch. **Maugin**: The possible utilisation of the diffraction diagrams of the X-rays for the complete determination of the structure of quartz.—A. **Nodon**: Experimental researches on the relations between terrestrial electrical phenomena, the state of the atmosphere, and solar foci.—Mlle. Marcelle **Guéraud**: The re-establishment of the genus Chlorocrepis in the tribe of the *Chicoraceae compositae*. *Hieracium staticefolium* was placed by Grisebach in a new species Chlorocrepis. Schultz regarded it as belonging to the genus Tolpis, and Villars placed it in the genus Hieracium, and this has been generally accepted. From the characters of the internal structure the author agrees with Grisebach, and is of the opinion that the genus Chlorocrepis should be reinstated.—R. **Souèges**: The embryogeny of the Boragacæ. The first steps of the development of the embryo in *Myosotis hispida*.—G. **Kühnholtz-Lordat**: The genetic phytogeography of the dunes of the Gulf of Lyons.—M. **Stoquer**: The influence of the temperature on the absorbent properties of soils.—J. L. **Lichtenstein**: The biology of *Habrocytus cionicida*.—F. **Angel**: The development of *Molge Waltlii* and its habitat in French Guinea.—E. **Fauré-Fremiet**: The laws of growth of the tissues constituting the fœtal lung of the sheep.—E. F. **Terroine** and H. **Barthélémy**: The existence of biometrical relations between the red frog, *Rana fusca*, and its eggs at the period of laying.—L. **Léger** and S. **Stankovitch**: The coccidiosis of the young of the carp.—L. **Blum**: A new group of diuretics; interstitial diuretics. Diuresis by the displacement of ions.—T. **Jonnesco**: The treatment of facial neuralgia by the resection of the cervico-thoracic sympathetic nerve.

SYDNEY.

Royal Society of New South Wales, September 7.—Mr. E. C. Andrews, president, in the chair.—G. H. **Halligan**: The ocean currents around Australia. The South Australian current, sweeping the whole of the southern shore of Australia from Cape Leeuwin to Tasmania, the East Australian current, flowing southwards, the Arafura Sea current, and the currents of the north-west and west coasts are described and traced. Immediate and systematic investigation of the ocean currents around Australia is advocated in the interests of both commerce and the safety of the mercantile marine.—J. H. **Maiden**: Records of Australian botanists. Brief sketches were given of the following:—William Anderson, surgeon of Capt. Cook's third voyage from 1776 to 1779; F. M. Bailey, who for forty years (1875–1915) held botanical appointments in Queensland; E. Betche, who was connected with the Sydney Botanic Gardens from 1881 to 1916; H. H. Bradley, famous for his horticultural work; and W. R. Guilfoyle, who successfully remodelled the Melbourne Botanic Gardens.

Books Received.

A First Book in Algebra. By Dr. F. Durell and E. E. Arnold. Pp. v+339+xl. (New York and Chicago: C. E. Merrill Co.)

A Second Book in Algebra. By Dr. F. Durell and E. E. Arnold. Pp. v+330+xliii. (New York and Chicago: C. E. Merrill Co.)

Plane and Solid Geometry. By Dr. F. Durell and E. E. Arnold. Pp. 503. (New York and Chicago: C. E. Merrill Co.)

A Catalogue of British Scientific and Technical Books, covering every Branch of Science and Technology, carefully Classified and Indexed. Prepared by a Committee of the British Science Guild. Pp. xviii+376. (London: British Science Guild, 6 John Street.) 10*s.* net.

The Rainbow Bridge. By R. Farrer. Pp. xi+383. (London: E. Arnold and Co.) 21*s.* net.

A Text-Book of European Archæology. By Prof. R. A. S. Macalister. Vol. 1: The Palæolithic Period. Pp. xv+610. (Cambridge: At the University Press.) 50*s.* net.

A Text-Book of Wood. By H. Stone. Pp. vii+240+41 plates. (London: W. Rider and Son, Ltd.) 21*s.* net.

Eléments d'Analyse Mathématique à l'Usage des Candidats au Certificat de Mathématiques générales des Ingénieurs et des Physiciens. Cours Professé à l'Ecole Centrale des Arts et Manufactures. By Paul Appell. Quatrième édition, entièrement refondue. Pp. x+715. (Paris: Gauthier-Villars et Cie.)

Contributions to the Biology of the Danish Culicidæ. By C. Wesenberg-Lund. (D. Kgl. Danske Vidensk Selsk. Skrifter, Naturv. og Mathematisk, Afd. 8, Raekke vii., 1.) Pp. 210+21 plates. (København: A. F. Høst & Son.) 29 krone.

University of Illinois Bulletin, vol. 13, No. 45: The Genus Phoradendron. By Prof. W. Trelease. Pp. 224+245 plates. (Urbana: University of Illinois; London: Wheldon and Wesley, Ltd.) 2 dollars.

Publications of the United States Naval Observatory. Second series, vol. ix (in four parts). Part 1, Results of Observations with the Nine-inch Transit Circle, 1903–1911. Reduced under the direction of W. S. Eichelberger. Pp. cdlxi+452+6 plates. (Washington: Government Printing Office.)

Smithsonian Institution: United States National Museum. Bulletin 116: The Dipterous Genus Dolichopus Latreille in North America. By M. C. Van Duzee, F. R. Cole, and J. M. Aldrich. Pp. iv+304+16 plates. (Washington: Government Printing Office.)

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium, vol. 22, part 5: Flora of Glacier, National Park, Montana. By P. C. Standley. Pp. viii+235–438+plates 33–52+ix–xix. (Washington: Government Printing Office.)

Smithsonian Institution: Bureau of American Ethnology. Bulletin 72: The Owl Sacred Pack of the Fox Indians. By T. Michelson. Pp. 84+4 plates. (Washington: Government Printing Office.)

Papers of the Peabody Museum of American Archæology and Ethnology, Harvard University. Vol. 8, No. 2: Basket-maker Caves of North-eastern Arizona. Report on the Explorations, 1916–17. By S. J. Guernsey and A. V. Kidder. Pp. vii+121+44 plates. (Cambridge, Mass.: Peabody Museum.)

Memoirs of the American Museum of Natural History. New Series. Vol. 3, part 2: On the Structure and Relations of *Notharctus*, an American Eocene Primate. By W. K. Gregory. Pp. 45–244+plates 22–50. Vol. 3, part 3: *Camarasaurus*, *Amphicaelias*, and other Sauropods of Cope. By H. F. Osborn and C. C. Mook. Pp. 245–387+plates 60–85. (New York: American Museum of Natural History.)

Leland Stanford Junior University Publications: University Series. Fossil Fishes of Diatom Beds of Lompoc, California. By D. S. Jordan and J. Z. Gilbert. Pp. 44+29 plates. The Genera of Fishes. By D. S. Jordan. Part 2: From Agassiz to Bleeker, 1833–58. A Contribution to the Stability of Scientific Nomenclature. Pp. ix+163–284+xiii. Part 3: From Guenther to Gill, 1859–80. Pp. ii+285–410+xv. Part 4: From 1881–1920. Pp. 411–576+xviii. Contributions toward a Monograph of the Sucking Lice. By G. F. Ferris. Part 1. Pp. 51. Studies in Ichthyology: A Monographic Review of the Family of Atherinidæ or Silversides. By D. S. Jordan and C. N. Hubbs. Pp. 87+12 plates. The Electrical Charges of Atoms and Ions. By Prof. F. Stanford. Pp. 130. Fossil Fishes of Southern California. By D. S. Jordan and J. Z. Gilbert. Pp. 66+21 plates. Biological Sciences: Vol 1, No. 1. Scale Insects of the Santa Cruz Peninsula. By G. F. Ferris. Pp. 58. Vol. 1, No. 2. Report upon a Collection of Coccidæ from Lower California. By G. F. Ferris. Pp. 59–132. (California: Stanford University.)

Das Problem der Genesis des Actiniums. By M. C. Neuburger. Pp. iii+64. (Stuttgart: F. Enke.) 5 marks.

Raum und Zeit im Lichte der Speziellen Relativitätstheorie. By Dr. C. von Horvath. Pp. v+58. (Berlin: J. Springer.) In Germany, 12 marks; in England, 36 marks.

Capita Zoologica. Verhandelingen op Systematisch-Zoologisch Gebied onder Redactie van Prof. Dr. E. D. van Oort. Deel 1, Aflevering 1: Nouvelles Recherches sur les Nématodes Libres Terricoles de la Hollande. By Dr. J. G. De Man. Pp. 62+14 plates. 10 guilders. Deel 1, Aflevering 2: Studien über Rhizostomeen mit Besonderer Berücksichtigung der Fauna des Malaiischen Archipels nebst einen Revision des Systems. By Dr. Gustav Stiasny. Pp. viii+176+5 plates. 16 guilders. ('s-Gravenhage: Martinus Nijhoff.)

University of London: Galton Laboratory for National Eugenics. Eugenics Laboratory Memoirs, vii.: On the Relationship of the Condition of the Teeth in Children to Factors of Health and Home Environment. By E. C. Rhodes. Pp. viii+80. (London: Cambridge University Press.) 9*s.* net.

Osmania Observatory, Hyderabad: Publications of the Nizamiah Observatory. Astrographic Catalogue 1900·0. Hyderabad Section. Dec. −16° to −21°. From Photographs taken and measured at the Nizamiah Observatory, Hyderabad, under the direction of the late R. J. Pocock. Completed under the supervision of T. P. Bhaskaran. Vol. 4: Measures of Rectangular Co-ordinates and Diameters of 79,590 Star-Images on Plates with Centres in Dec. −20°. (Hyderabad.)

A Manual of Practical Anatomy: A Guide to the Dissection of the Human Body. By Prof. T. Walmsley. (In three parts.) Part 2: The Thorax and Abdomen. Pp. v+233. (London: Longmans, Green and Co.) 10*s.* 6*d.* net.

The Dawn of Modern Medicine: An Account of the Revival of the Science and Art of Medicine which took place in Western Europe during the latter half of the 18th Century and the first part of the 19th. By Dr. A. H. Buck. Pp. xix+288. (New Haven: Yale University Press; London: Oxford University Press.) 25*s.* net.

The Witch-Cult in Western Europe: A Study in Anthropology. By M. A. Murray. Pp. 303. (Oxford: Clarendon Press.) 16*s.* net.

Western Australia: Geological Survey. Bulletin No. 81: The Mineral Resources of the Yalgoo Goldfield. Part 1: The Warriedar Gold-Mining Centre. By F. R. Feldtmann. Pp. 40+3 plates. Bulletin No. 79: The Mining Geology of Comet Vale and Goongarrie, North Coolgardie Goldfield. By J. T.

Jutson. Pp. 76+x+8 plates. Bulletin No. 80: The Mining Centres of Quinn's and Jasper Hill, Murchison Goldfield. By F. R. Feldtmann. Pp. 92+3 plates. (Perth: Geological Survey.)

Geschichte der Organischen Chemie. By Carl Graebe. Erster Band. Pp. x+406. (Berlin: J. Springer.) In Germany, 28 marks; in England, 84 marks.

The Ideas of Einstein's Theory: A Theory of Relativity in Simple Language. By Prof. J. H. Thirring. Translated by R. A. B. Russell. Pp. xv+167. (London: Methuen and Co., Ltd.) 5*s*. net.

Insect Transformation. By Prof. G. H. Carpenter. Pp. xi+282+4 plates. (London: Methuen and Co., Ltd.) 12*s*. 6*d*. net.

Electrodeposition and Electroplating. A General Discussion held at Sheffield, November, 1920. (Reprinted from the "Transactions of the Faraday Society," vol. 16, part 3, 1921.) Pp. iii+83. (London: Faraday Society.)

Memoirs of the Bernice Pauahi Bishop Museum. Vol. 8, No. 1: A Monographic Study of the Genus Pritchardia. By O. Beccari and J. F. Rock. Pp. ii+78+24 plates. Vol. 8, No. 2: Bayard Dominick Expedition. Publication No. 1: A Contribution to Samoan Somatology. Based on the Field Studies of E. W. Clifford and W. C. McKern. By L. R. Sullivan. Pp. 78–98+plates 25–30. (Honolulu.)

Potatoes and Pigs with Milk as the Basis of Britain's Food Supply. A Paper read before the British Association at Edinburgh, September 12, 1921. With some Hints as to the Production of Each. By Lord Bledisloe. Pp. 59. (London: Hugh Rees, Ltd.) 1*s*. net.

Die Pendulations-theorie. By Prof. Dr. H. Simroth. Zweite auflage. Pp. xvi+598. (Berlin: Konrad Grethlein.) 13.50 marks.

East Carelia and Kola Lapmark. Described by Finnish Scientists and Philologists. By Theodor Homén. Pp. xiv+264. (London: Longmans, Green and Co.) 21*s*. net.

Typical Flies: A Photographic Atlas. By E. K. Pearce. Second series. Pp. xiv+38. (Cambridge: At the University Press.) 15*s*. net.

Small Talk at Wreyland. By Cecil Torr. Second series. Pp. vi+120. (Cambridge: At the University Press.) 9*s*. net.

Common Plants. By Dr. M. Skene. (Common Things Series.) Pp. 271+26 plates. (London: A. Melrose, Ltd.) 6*s*. net.

Die Biochemie in Einzeldarstellungen. Herausgegeben von Dr. A. Kanitz. I.: Temperatur und Leblensvorgänge. By Dr. A. Kanitz. Pp. x+175. 54 marks. II.: Uber Künstliche Ernährung und Vitamine. By Prof. Dr. F. Röhmann. Pp. vi+150+2 plates. 42 marks. III.: Uber partielle Eiweisshydrolyse. By Prof. Dr. M. Siegfried. Pp. iv+64. 15 marks. IV.: Die Einwirkung von Mikroorganismen auf die Eiweisskörper. By Dr. P. Hirsch. Pp. x+256. 63 marks. (Berlin: Gebrüder Borntraeger.)

Catalogue of Double Stars from Observations made at the Royal Observatory, Greenwich, with the 28-inch Refractor during the years 1893–1919, under the Direction of Sir F. W. Dyson. Pp. xviii+229. (London: H.M. Stationery Office.) 25*s*. net.

Observations made with the Cookson Floating Zenith Telescope in the years 1911–1918 at the Royal Observatory, Greenwich, for the Determination of the Variation of Latitude and the Constant of Aberration, under the Direction of Sir F. Dyson. Pp. 76. (London: H.M. Stationery Office.) 7*s*. 6*d*. net.

Annals of the Cape Observatory. Vol. 8, part 5: Results of Meridian Observations of the Sun, Mercury, and Venus, made at the Royal Observatory, Cape of Good Hope, in the years 1912 to 1916, under the Direction of S. S. Hough. Pp. 87. (London: H.M. Stationery Office.) 7*s*. 6*d*. net.

Annals of the Cape Observatory. Vol. 10: Spectroscopic Researches. Part 5: The Radial Velocities of 120 Southern Stars, observed at the Cape. By Dr. J. Lunt. Pp. 19. 4*s*. net. Part 6: On the Variable Orbit of the Spectroscopic Binary, 42 Capricorni. By Dr. J. Lunt. Pp. 8. 1*s*. net. (London: H.M. Stationery Office.)

Results of Meridian Observations of Stars made at the Royal Observatory, Cape of Good Hope, in the years 1912–1917, under the Direction of S. S. Hough. Pp. xxii+442. (London: H.M. Stationery Office.) 70*s*. net.

Diary of Societies.

THURSDAY, NOVEMBER 10.

ROYAL SOCIETY, at 4.30.—A. J. Wilmott: Experimental Researches on Vegetable Assimilation and Respiration. XIV., Assimilation by Submerged Water Plants in Dilute Solutions of Bicarbonates and of Acids, and Improved Bubble Counting Technique.—E. G. Young: The Coagulation of Protein by Sunlight.—E. G. Young: The Optical Rotatory Power of Crystalline Ovalbumin and Serum Albumin.—A. R. Ling and D. R. Nanji: The Longevity of Certain Species of Yeast.—F. Kidd, C. West, and G. E. Briggs: A Quantitative Analysis of the Growth of *Helianthus annuus*. Part I., The Respiration of the Plant and of its Parts throughout the Life Cycle.—G. S. Currey: The Colouring Matter of Red Roses.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. R. O. Moon: Hippocrates in Relation to the Philosophy of his Time (Second FitzPatrick Lecture).

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—F. S. Marvin: The Teaching of History.

ROYAL AERONAUTICAL SOCIETY (Students' Section), at 7.—W. L. Le Page: The Soaring Flight Problem.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—Dr. A. Gleichen: The Path of Rays in Periscopes having an Inverting System comprising Two Separated Lenses.—Dr. J. W. French: The Interocular Distance.—T. Chaundy: Note on the Thin Astigmatic Lens.

INSTITUTE OF METALS (London Section) (at Royal School of Mines), at 8.—Prof. C. H. Desch: Plastic Flow in Metals.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Olympia).—T. Thornycroft; N. Macmillan: Marine Motors.

HARVEIAN SOCIETY OF LONDON (at Paddington Town Hall), at 8.30.—Dr. G. A. H. Barton: Ether: Some Simple Methods and Musings.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Sir William Thorburn and Dr. W. Harris: Discussion: The Treatment of Persistent Pain due to Lesions of the Central and Peripheral Nervous System.

FRIDAY, NOVEMBER 11.

OIL AND COLOUR CHEMISTS' ASSOCIATION.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—Sir William Bragg: The Structure of Organic Crystals (Presidential Address).

ROYAL ASTRONOMICAL SOCIETY, at 5.—W. H. Pickering: Suggested Explanation of Aberration.—A. R. Forsyth: Note on the Path of a Ray of Light in the Einstein Relativity Theory of Gravitational Effect.—I. van der Bilt: Observations of Minor Planets.—S. D. Tscherny: Observations of Comet 1921 (Reid).—H. S. Jones: Determination of the Photographic Scale of the North Polar Sequence.—E. E. Barnard: Variability of Nova Cygni 1876 (Schmidt).—F. C. Jordan: Note on Secondary Oscillations in the Light-curve of Cepheid Variables.—H. C. Plummer: Mr. Jordan's Note.—H. N. Russell and D. L. Webster: Note on the Masses of the Stars.—Sydney Observatory: Eclipses of Jupiter's Satellites I and II.—F. J. M. Stratton: The Spectrum of Nova Cygni III 1920.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 7.—Sir Philip Dawson: The Future of Railway Electrification.

JUNIOR INSTITUTION OF ENGINEERS, at 8.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—Dr. W. S. Inman: The Relationship of Squint, Left-handedness, and Stammering.—Dr. C. F. Harford: The New Psychology and its Relation to Problems of Vision.

MONDAY, NOVEMBER 14.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge, Kensington Gore), at 5.—F. Dixey: The Physiography of Sierra Leone.

SURVEYORS' INSTITUTION, at 8.—J. H. Sabin: Presidential Address.

CHEMICAL INDUSTRY CLUB (at 2 Whitehall Court).—E. H. Scholl: Remarks on a Recent Trade Visit to Germany.

TUESDAY, NOVEMBER 15.

ROYAL HORTICULTURAL SOCIETY, at 3.—W. F. Bewley: Diseases of Tomatoes.

ROYAL STATISTICAL SOCIETY, at 5.15.

INSTITUTION OF CIVIL ENGINEERS, at 6.—F. G. Royal-Dawson: The Indian Railway Gauge Problem.

ROYAL PHOTOGRAPHIC SOCIETY, at 7.—F. R. D. Onslow: Some Sea Birds.
ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 8.—Reports on Progress during the Vacation, and Developments in Gas Lamps and Electric Lamps and Lighting Appliances.
ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Miss M. Murray: Recent Excavations in Malta.
MEDICO-LEGAL SOCIETY (at 11 Chandos Street, W.1), at 8.30.—Dr. T. Good: Nature *versus* Law.

WEDNESDAY, NOVEMBER 16.

ROYAL HORTICULTURAL SOCIETY, at 10.30—5.30.—International Potato Conference.
ROYAL SOCIETY OF ARTS, at 4.30.—T. H. Lyon: Modern Buildings in Cambridge and their Architecture.
ROYAL METEOROLOGICAL SOCIETY, at 5.—Dr. H. Jeffreys: The Dynamics of Wind.—N. K. Johnson: The Behaviour of Pilot Balloons at Great Heights.—C. J. P. Cave: The Cloud Phenomenon of November 29, 1920.
NEWCOMEN SOCIETY (at Caxton Hall), at 5.—C. F. D. Marshall: The Liverpool and Manchester Railway.
ENTOMOLOGICAL SOCIETY OF LONDON, at 8.
ROYAL MICROSCOPICAL SOCIETY, at 8.—G. Patchin: The Micro-examination of Metals with Special Reference to Silver, Gold, and the Platinum Metals.—R. L. Frink: The Practical Value of the Microscope in Glass Manufacture.—W. C. Crawley and Dr. H. A. Baylis: Mermis Parasitic on Ants of the genus Lasius.

THURSDAY, NOVEMBER 17.

ROYAL HORTICULTURAL SOCIETY, at 10—6.—International Potato Conference.
ROYAL SOCIETY, at 4.30.—*Probable Papers.*—Major P. A. MacMahon and W. P. D. MacMahon: The Design of Repeating Patterns.—Prof. J. W. Nicholson: A Problem in the Theory of Heat Conduction.—Prof. C. H. Lees: The Thermal Stresses in Spherical Shells Concentrically Heated.—R. A. Fisher: The Mathematical Foundations of Theoretical Statistics.—F. P. White: The Diffraction of Plane Electromagnetic Waves by a Perfectly Reflecting Sphere.—Prof. C. V. Raman and G. A. Sutherland: The Whispering Gallery Phenomenon.
LINNEAN SOCIETY OF LONDON, at 5.
LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5 (Annual General Meeting).
ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Col. F. Searle: Requirements and Difficulties of Air Transport.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—E. S. Byng: Telephone Line Work in the United States.
INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—H. F. Collins: The Igneous Rocks of the Province of Huelva and the Genesis of the Pyritic Orebodies.
CHEMICAL SOCIETY, at 8.—H. Burton and J. Kenner: The Influence of Nitro-groups on the Reactivity of Substituents in the Benzene Nucleus. Part V., Heteronuclear Dinitro-derivatives.—F. Challenger and J. F. Wilkinson: Organo-derivatives of Bismuth. Part V., The Stability of Halogen, Cyano-, and Thiocyano-derivatives of Tertiary Aromatic Bismuthines.—F. Challenger and L. R. Ridgway: Organo-derivatives of Bismuth. Part VI., The Preparation and Properties of Tertiary Aromatic Bismuthines and their Interaction with Organic and Inorganic Halogen Compounds.

FRIDAY, NOVEMBER 18.

ROYAL HORTICULTURAL SOCIETY, at 10.30—1.30.—International Potato Conference.
ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botanical Lecture Theatre, Imperial College of Science and Technology), at 3.—Dr. E. J. Butler and others: Discussion: Meteorological Conditions and Disease.
INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Dr. E. H. Salmon: The Machinery of Floating Docks.

SATURDAY, NOVEMBER 19.

BRITISH MYCOLOGICAL SOCIETY (in Botany Lecture Theatre, University College).
PHYSIOLOGICAL SOCIETY (at St. Bartholomew's Hospital).

PUBLIC LECTURES.

(A number in brackets indicates the number of a lecture in a series.)

THURSDAY, NOVEMBER 10.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 3.—W. Bateson: Recent Advances in Genetics (2).
UNIVERSITY COLLEGE, at 5.—Prof. J. E. G. De Montmorency: European Feudalism: Its Variation and Decay (2).
KING'S COLLEGE, at 5.30.—H. W. Fitz-Simons: Bridge Construction (3).
GRESHAM COLLEGE, at 6.—Prof. W. H. Wagstaff: Time-Units (3).
BIRKBECK COLLEGE, at 7.30.—Prof. F. Soddy: The Bearing of Physical Science on Economics (1).

FRIDAY, NOVEMBER 11.

UNIVERSITY COLLEGE, at 4.30.—Dr. J. C. Drummond: Nutrition (5). At 8.—Prof. G. Dawes Hicks: Our Knowledge of the Real World (2).
IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Dr. J. D. Falconer: The Wonders of Geology (Swiney Lectures) (3).
GRESHAM COLLEGE, at 6.—Prof. W. H. Wagstaff: Time-Units (4).

SATURDAY, NOVEMBER 12.

POLYTECHNIC, REGENT STREET, at 10.30.—Prof. H. E. Armstrong: The Wonders and Problems of Food.

MONDAY, NOVEMBER 14.

UNIVERSITY COLLEGE, at 5.—Prof. E. G. Coker: Recent Researches in Photo-elasticity.
IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Dr. J. D. Falconer: The Wonders of Geology (Swiney Lectures) (4).
KING'S COLLEGE, at 5.30.—H. Moore: Liquid Fuels (3).
KING'S COLLEGE, at 8.—Dr. E. J. Russell: Modern Applications of Chemistry to Crop Production.

TUESDAY, NOVEMBER 15.

KING'S COLLEGE, at 5.30.—Prof. H. Wildon Carr: The Modern Scientific Revolution and its Meaning for Philosophy (6); The Theory of Natural Selection.—Dr. W. Brown: Psychology and Psycho-therapy (5).—L. J. Hunt: Cascade Synchronous Motors and Generators (5).

WEDNESDAY, NOVEMBER 16.

UNIVERSITY COLLEGE, at 3.—Prof. E. G. Gardner: Nature in the *Divina Commedia* (2).
KING'S COLLEGE, at 4.30.—Dr. C. Da Fano: Histology of the Nervous System (6).
ROBERT BARNES HALL, 1 Wimpole Street, W.1, at 5.—Prof. Mellanby: Vitamines and Health.
KING'S COLLEGE, at 5.15.—Prof. G. Elliot Smith: Anthropology.
IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Dr. J. D. Falconer: The Wonders of Geology (Swiney Lectures) (5).

THURSDAY, NOVEMBER 17.

UNIVERSITY COLLEGE, at 5.—Prof. J. E. G. De Montmorency: The Background of Non-European Feudalism (3).
IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—W. Bateson: Recent Advances in Genetics (3).
BIRKBECK COLLEGE, at 7.30.—Prof. F. Soddy: The Bearing of Physical Science on Economics (2).

FRIDAY, NOVEMBER 18.

UNIVERSITY COLLEGE, at 4.30.—Dr. J. C. Drummond: Nutrition (6).
IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Dr. J. D. Falconer: The Wonders of Geology (Swiney Lectures) (6).
UNIVERSITY COLLEGE, at 8.—Prof. G. Dawes Hicks: Our Knowledge of the Real World (3).

CONTENTS.

	PAGE
Applied Anthropology	329
Chemical Warfare. By Sir T. E. Thorpe, C.B., F.R.S.	331
Alfred Newton, Ornithologist. By W. E. C.	333
Fruits of the Tropics and Subtropics	334
Our Bookshelf	334
Letters to the Editor:—	
The Age of the Earth.—Right Hon. Lord Rayleigh, F.R.S.	335
Inheritance, Mendelism, and Mutation.—Sir G. Archdall Reid, K.B.E.	335
Methods of Improving Visibility.—A. G. Lowndes; Capt. Sir David Wilson-Barker	337
Penial and Genital Setæ of *Lumbricus terrestris*, L., Müll. (*Illustrated.*)—Dr. J. Stephenson	337
Speaking Films.—Lough Pendred; Prof. A. O. Rankine	338
The Differentiation of Boiled and Unboiled Water.—Dr. W. R. G. Atkins	339
Ophion luteus.—Right Hon. Sir Herbert Maxwell, Bart., F.R.S.	339
Indian Land Mollusca.—Dr. N. Annandale	340
Curiosities of Nomenclature.—Rev. T. R. R. Stebbing, F.R.S.	340
The Flight of Thistledown.—W. E. Lishman; Lewis F. Richardson	340
Ceratium and Pedalion.—A. E. Harris	340
Muscular Piezo-electricity?—F. Buchanan	340
Faraday and the Quantum. By Dr. H. Stanley Allen	341
The Mineral Industry of India. By Prof. Henry Louis	343
Liquid Air Explosives	344
Obituary:—	
Prof. F. A. Bainbridge, F.R.S. By W. D. H.	344
Dr. W. S. Bruce. By R. N. R. B.	345
Prof. F. E. Armstrong. By C. H. D.	346
Notes	347
Our Astronomical Column:—	
The French Wireless Time-Signals	351
Proper Motions of Long-period Variable Stars	351
The Last Glacial Epoch	351
The Structure of Adularia and Moonstone. (*Illustrated.*) By Dr. A. E. H. Tutton, F.R.S.	352
Tissue Metabolism	353
Melanesian Land-tenure	354
University and Educational Intelligence	354
Calendar of Scientific Pioneers	356
Societies and Academies	356
Books Received	357
Diary of Societies	359

THURSDAY, NOVEMBER 17, 1921.

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University Grants.

THE governing bodies and teaching staffs of the universities will view with dismay the proposal of the Lords Commissioners of H.M. Treasury to reduce the annual grant-in-aid of university education from 1,500,000*l.*, at which it stands in the current year, to 1,200,000*l.* for the coming financial year 1922–23.

It will be recalled that in the Estimates for 1921–22 a sum of 500,000*l.* was added to the annual grant, which at that time stood at one million. Of this 500,000*l.* it appears that 200,000*l.* has already been allocated in the form of *annual* grants to the various institutions participating in Parliamentary grant, while it is presumed that the remaining 300,000*l.* has been, or will be, available for non-recurrent allocation. On some such assumption it is explainable how the sum of 1,200,000*l.* has been arrived at. If the reduction of 300,000*l.* is agreed to by Parliament there will be in consequence no addition in the coming financial year to the annual grants now paid to these institutions, and obviously no non-recurrent allocation.

In the light of these statements it is important to review the question of university grants. Two facts are clear: (1) When Parliament voted the additional annual grant of half a million last session it did so on the ground of necessary and essential expenditure—this was made perfectly clear by Sir Philip Magnus and others in the debate on the Estimates; and (2) the governing bodies and teaching staffs of the universities assumed, and with perfect justification, that the grant, voted as an *annual* grant, would be disbursed as such. That only 200,000*l.* was allocated as annual grant and the rest as a non-recurrent allocation—a principle which, whatever its good points, is open to serious criticism—does not make the assumption less justifiable. Accordingly it was perfectly legitimate for the universities to make their plans in the belief that the 300,000*l.* would be available in succeeding years. The withdrawal will mean that these institutions will be let down and let down badly. One can readily understand why, at the recent opening of a bazaar to raise funds for Manchester University, "this grave fact was a subject of pained comment" by the vice-chancellor. "Comment" characterised by quite a different word from "pained" would not have surprised us. Sir H. A. Miers must have exercised great restraint on that occasion.

If the additional grant of 500,000*l.* is necessary and essential for the current year, what is the reason for the proposed withdrawal of three-fifths of it for next year? Is it less necessary or essential then, or is there some other reason? The plea of national economy cannot be justified. Very little consideration will show that to curtail the range of university education or to limit its possibilities is to curtail and limit the progress of civilisation, whether in things of the spirit or in the organisation and development of science as applied to commerce and industry. It is a short-sighted policy and one fraught with sinister import if the highest institutions of learning in the country are allowed to flounder in a morass of financial difficulties. It is certainly economy, but economy of a peculiar kind; it is the economy which leads to spiritual and material bankruptcy.

Let us examine the question a little more closely. Last February the University Grants Committee reported in no doubtful terms upon the clamant needs of the universities, and in particular upon the emoluments of university teachers. The report stated that the salaries were still below the minimum necessitated by economic conditions, and that the committee was satisfied that unless further substantial improvement was made the efficiency of university education would be seriously endangered. It went on to say that "the best men and women would neither enter nor continue in the profession at the rate of salaries then within the competence of the authorities to offer, nor could a teacher under the perpetual shadow of financial anxieties give his best to the work of instruction and research." This statement, strong as it is, has been amply confirmed by the difficulties which various departments in the universi-

ties are experiencing at the present time in recruiting their staffs.

Upon the strength of this report, together with representations made to Parliament by various interested bodies, the additional annual grant referred to above was made by Parliament. Now it is proposed to ask Parliament to cut down this grant. Such a proposal, in our opinion, can be justified only if it is shown that the grant is neither necessary nor essential in the coming year. Without considering the question of the further development of the universities, all-important as it is, let us examine one of the factors in the situation—university stipends.

Last July a conference of the heads of university institutions, the non-academic members of university governing bodies, and the council of the Association of University Teachers approved of a scale of minimum salaries for university teachers. This scale is extremely moderate, and, as a *minimum* scale, seems likely to meet with general approval. On the basis of these very reasonable proposals it was estimated that it would require an additional sum of about 400,000*l.* to raise the full-time teachers in university institutions in England and Wales to the minimum salary of the scale. Assuming that since the date when the Estimate was made an aggregate sum of 100,000*l.* has been added to the emoluments of the university teachers referred to, there still remains a sum of 300,000*l.* required to raise these teachers to their minimum on the scale. In this figure no allowance is made for an increase in the number of teachers or in the stipends of those who have reached their minimum.

Thus at the very time when an annual sum of 300,000*l.* is required in England and Wales to put university teachers on a minimum scale, which has been drawn up with due and proper consideration of the necessity of national economy, the Lords Commissioners of the Treasury propose to reduce the annual grant by 300,000*l.*, precisely the sum which, if distributed as an annual grant for salary purposes, would have enabled the university authorities to establish a reasonable and just scale of remuneration. Is it any wonder that the governing bodies and teaching staffs of the universities are dismayed at the proposal? We trust, however, that Parliament will not deal with our universities in this fashion, but, recognising that their necessities will be no less in the coming year than they are at the present moment, decline to be a party to a proposal which, in our opinion, from whatever side it is examined, cannot be justified.

Psychological Medicine.

The Basis of Psychiatry. By Dr. Albert C. Buckley. Pp. xii+447. (Philadelphia and London: J. B. Lippincott Co., 1920.) 30*s.* net.

AT the present time, when great interest is being taken by both public and Press in the questions of body in relation to mind, psycho-analysis in the treatment of the psychoneuroses and psychoses, and the necessity of lunacy reform, a book which deals comprehensively with the subject of psychological medicine is especially welcome. Moreover, now that the conjoint board of the Royal Colleges of Physicians and Surgeons and many of the universities, notably Cambridge and London, have instituted a diploma of psychological medicine, a book such as "The Basis of Psychiatry" is notably opportune, and we have no hesitation in recommending this book strongly to students and practitioners, for it satisfies a long-felt want.

The author first discusses biologic phenomena, including the laws of heredity and their application to mental and nervous diseases. Then follows a brief but useful chapter on cerebral development and receptive organs, with a description of the autonomic system and its functions. We are rather surprised to find that no mention is made of Hughlings Jackson's levels. The author shows how sensitivity and differential sensitivity constitute fundamental biological phenomena, but Head's theory of protopathic and epicritic sensibility is not alluded to. This may be an omission on account of space rather than disbelief in its validity.

Chap. 5 is devoted to psychological processes, and should prove very useful to students and practitioners, for it enables the reader to grasp principles and become familiar with psychological terms sufficiently to enable him to understand and express in suitable language disorders of the mind.

Since psycho-analysis is at the present time attracting so much attention of the profession, the public mind, and the Press, it will be interesting to consider a little fully the views of Prof. Buckley. The doctrine of the unconscious mind is discussed, and the author points out that it was an outgrowth of abnormal psychology led by Charcot and continued by his pupils Janet and Freud. He describes briefly Janet's pioneer work on dissociation of consciousness upon the basis of which the symptoms commonly met in hysteria were explained by the eminent French psychiatrist. The further development of the unconscious by Freud, according to whom psychoneuroses are due to a complex carrying with it a

mentally painful emotional tone, is also discussed briefly. His theory of repression of painful experiences and mental conflict are referred to, but no mention is made of infantile repression, the theory of erogenous zones, and the analysis of dreams and their significance, to which so much importance is attached by psycho-analysts. We are of opinion that a fuller account and criticism of Freud's theories, whether the author is in agreement therewith or not, would have been of service to the student and practitioner. Whatever view Prof. Buckley takes of the Freudian theories he certainly is not in agreement with treatment by psycho-analysis, for he says :—

"The matter of psycho-analysis has as yet not reached its proper level. Until that condition has been reached it would be well to accept those portions of it that can be demonstrated beyond hypothetical bounds to be of real value and avoid as far as possible going out of the way to inject into the fatigued patient's mind a score of ideas which though 'submerged' in the unconscious, possibly may do less harm than if brought to the patient's realisation."

Another matter which we have indicated previously as arousing public interest and exciting an uneasy feeling in a large section of the public at the present time is the failure to adopt hospital methods of treatment of recoverable cases in our large asylums in accordance with medical science. At present these institutions are, generally speaking, mental hospitals only in name. They appear in a large number of instances to be really institutions of detention in which recoverable cases are herded together with, and treated in the same old institutional manner as, the chronic and senile cases. The superintendent of an institution in which the majority of cases demand merely administrative duties tends to grow out of touch with medical science and progress. Mental hospitals for the recoverable cases are urgently needed in which medical officers are able to apply hospital methods of psychological, clinical, and laboratory investigation of the patients committed to their care.

Methods are described and their utility in diagnosis, prognosis, and treatment are admirably discussed by Prof. Buckley, who, from the following paragraph in the preface, clearly emphasises the importance of treating the bodily condition :—

"As physicians and practitioners we have come to consider the group of mental disorders which belong to the class of recoverable psychoses, not primarily as mental diseases, but as reflections of some bodily disorder, which through its effect upon the organ of adjustment, the nervous mechanism and its lower and higher (psychic) reflexes prevents the patient from making the necessary appropriate adaptations to environmental conditions, and therefore constitutes a thoroughly biological problem."

The author gives three fundamental groups of factors in the production of mental disorders.

"(1) The biogenetic factor dependent upon defects of development, either structural or functional; (2) disturbances of function brought about by toxic agents either exogenous or endogenous; (3) organic neuronic changes, occurring either as primary disintegrative processes or structural changes secondary to pathologic conditions in non-neuronic structures."

The most important question in reference to the etiology, prognosis, and treatment resolves itself into the matter of determining first of all to which of these three groups the case belongs. After eliminating the psychoses which may be the result of bodily disturbances there remains a group of biogenetic psychoses comprising dementia præcox and the manic-depressive psychosis, "which develop upon an inherently defective foundation." "The dementia præcox patients present an original defect, which is intensified by some as yet unknown operative cause." The author does not refer to the researches of Mott upon the reproductive organs, who has shown a primary, germinal, regressive atrophy of the testis and ovary, which he correlates with the primary nuclear degeneration of the neuron affecting first the highest evolutional level. Nor does he refer to the same observer's researches upon the ages of admission to asylums of more than 3000 relatives, showing that the offspring of insane parents exhibit a marked tendency to have their first attack at a much earlier age. This antedating or anticipation tends to elimination of the unfit by bringing the disease on in adolescence, rendering the subject unable to compete with his fellows, and antisocial, thereby necessitating segregation. These psychoses are not peculiar to civilised races, and are doubtless due to germinal variation.

Nevertheless, Prof. Buckley's work is excellent and calls for little criticism, though we are of opinion that the pathology of mental diseases is not on the same high level and as up-to-date as the clinical and therapeutic portions of it. To take an example, in discussing the symptoms of myxœdema the author does not refer to the fact of the diminution and, in extreme cases, of the disappearance of the Nissl substance in the neurones, while the important functions of the cortex adrenalis are not mentioned.

There are seventy-nine excellent illustrations, mainly anatomical, psychological, clinical, and

experimental, but the cost of the coloured plate in the frontispiece, presumably an advertisement of the publishers, would have been better expended in illustrating such pathological changes as are known in the explanation of mental disease. The bibliography at the end of each chapter is valuable, and the index is well compiled. We hope to see published at an early date a second edition of this valuable text-book.

British Mammals.

British Mammals. Written and illustrated by A. Thorburn. (In two vols.) Vol. 2. Pp. vi + 108 + plates 26–50. (London : Longmans, Green and Co., 1921.) 10*l.* 10*s.* net (2 vols.).

IT is somewhat unfortunate that seals, whales, and bats constitute so large a proportion of our mammals, for the public, after all, take a lively interest only in such creatures as come under their notice. Including sub-species, there are roughly eighty in all, of which twenty-eight are sea creatures, mostly rare and generally thrown up on our coasts in a decomposing condition, whilst the bats, which number twelve, being crepuscular or nocturnal in their habits, are also known to few. When we add to this total the rats, mice, and voles, for the most part shy and elusive inhabitants of the earth, the total number of British mammals that come under the notice even of the most observant country dwellers is remarkably small.

In his second volume Mr. Thorburn treats his subject with the same care and attention to detail that he gave to us in volume one. Even when the subject is somewhat dull he succeeds in making an interesting feature of it by means of skilfully introduced natural features or landscape. We cannot say, however, that in the present volume he is equally at home in depicting deer or the so-called wild cattle as he is with the small rodents or Cetaceæ. The mountain hare is good, but the common hare is stiff and inartistic. Of all our mammals it is the most difficult to draw, and in this case the artist has failed to reproduce it in one of its more favourable attitudes. Nor are we enamoured of the pen drawings; they fall far behind the brush work, and being reproduced on pure rag-paper lose much of their original delicacy. In his coloured plates of mice and voles Mr. Thorburn is at his best, and that is saying a great deal, for it is evident he has drawn the majority of these from life, and has given us all their sleek beauty and rotundity. Here his art is triumphant, which is to say it is entirely satisfactory. Such work will live and hold its own, and take high place among works on British birds and beasts. Mr. Thorburn, too, has achieved a notable success in his representations of the British Cetaceæ, difficult subjects either to render accurately or to make interesting. We notice few errors, with the exception that the teeth of the sperm whale are too small and too white, while the head and flippers of the hump-backed whale are scarcely long enough.

The letterpress gives a short and on the whole very accurate account of all the species of rodents, ungulates, and whales. The author describes each species from careful research in standard works, supplemented by interesting little notes from personal observation. That he is a real lover of animals is evinced on every page where he describes the intimate habits of little harvest mice and other small creatures that he has kept in confinement and allowed to escape when they have been sufficiently studied and have sat for their portraits.

The second volume of "British Mammals" is a notable achievement and worthy of Mr. Thorburn's high reputation, but it is not on a level with the first volume. The printing, both of the coloured plates and of the text illustrations, leaves much to be desired. These faults, however, cannot be attributed either to the author or his publishers, but are due to the carelessness of printers and block- and paper-makers, who, we think, do not take the same care and pride in their work as in pre-war days. J. G. M.

Plant Biochemistry.

The Chemistry of Plant Life. By Dr. R. W. Thatcher. (Agricultural and Biological Publications.) Pp. xvi + 268. (New York and London : McGraw-Hill Book Co., Inc., 1921.) 18*s.* net.

OF recent years much attention has been given to plant- or phyto-chemistry, if we may judge from the number of books which have been published on the subject. The origin of this attention can be traced to the strides that have been made in the organic chemistry of the carbohydrates, proteins, and other complex compounds, and to the development and wide general applications of physical chemistry. The purely chemical and physical details are the essential foundations for a proper understanding of the subject and for throwing new light upon the complicated chemical and physical processes going on simultaneously in life. Authors of books on plant chemistry have an advantage over their colleagues in the other branch of biochemistry—physiological or animal chemistry—in not being cumbered with a mass of

material which may be described as traditional, and requires considerable pruning.

Dr. Thatcher's aim has been to present the chemical and physical details in an elementary manner, to point out their application in plant life, and at the same time to instil a spirit of inquiry into his readers. We think he has succeeded in his efforts. A previous acquaintance of elementary inorganic and organic chemistry is assumed, and it depends upon the depth of this acquaintance whether the student will grasp the contents. There will be no difficulty with the chapters on plant nutrients and photo-synthesis, but unless stereochemistry has been previously well learnt, the carbohydrate chapter will scarcely be understood. Herein we miss the equations for the formation of osazones. Also we can scarcely agree with the author that tannins are glucosides. Chlorophyll and plant pigments are really the most complicated in structure of plant products, and might well have formed the last chapter, instead of preceding organic acids, esters, and fats. Too little space is given to the nitrogenous constituents —a single chapter includes amines, alkaloids, purine and pyrimidine bases, and nucleic acid— while the classification of proteins is more complicated than usual.

The last third of the book deals with enzymes, colloids, and physical chemistry, mainly to show their importance in plant life. Finally there is a brief reference to hormones, auximones, vitamins, and toxins. Altogether, the book gives an excellent orientation of the subject, and much should be learned from it by the student; at any rate, he could probe further if he so desires, for references are given at the end of each chapter.

Our Bookshelf.

A History of the Cambridge University Press, 1521–1921. By S. C. Roberts. Pp. xv+190. (Cambridge: At the University Press, 1921.) 17*s.* 6*d.* net.

MR. ROBERTS'S "History of the Cambridge University Press" is a very interesting account of the difficulties met with in the gradual advance from small beginnings, culminating in the highly efficient organisation of the present time. The numerous illustrations representing title-pages and the list of books published between 1521 and 1750 add much to its value.

John Siberch, otherwise John Laer of Siegburg, near Cologne, set up the first printing press in Cambridge in 1520, having settled there probably at the wish of his friend and patron, Erasmus, who in 1510 had come to live in the turret chamber of Queens' College, and to be the first teacher of Greek at the University.

There are examples of several books printed by Siberch at Cambridge in 1521. He may thus be looked upon as the founder of the Cambridge University Press. Accordingly, 1921 is the four hundredth anniversary of University printing in Cambridge.

It is not clear that John Siberch was officially recognised as printer to the University, but in 1534 King Henry VIII., by letters patent, gave licence to the chancellor, masters, and scholars to elect from time to time three stationers and printers or sellers of books, residing within the University.

The Stationers Company of London repeatedly but unsuccessfully challenged the rights thus conferred upon the University, until they were finally confirmed in a Charter granted in 1628 by Charles I.

Although it appointed printers, the press did not come directly under the control of the University until 1697, when, by a grace of the senate, the first Press Syndicate was appointed.

A Text-book of Physics. Edited by A. Wilmer Duff. Fifth edition, revised. Pp. xiv+700. (London: J. and A. Churchill, 1921.) 16*s.* net.

No sweeping changes appear to have been made in the "Text-book of Physics," edited by Prof. A. Wilmer Duff, since the last edition, referred to in NATURE of March 15, 1917, p. 41, was published. The editor states in his new preface that "students of college Physics should have some acquaintance with such new and live topics of scientific, and even popular interest" as wireless telegraphy and telephony, sound-ranging, submarine detectors, the diffraction of X-rays, the instruments used in aeroplanes, and the principle of relativity, but with the exception of the paragraphs dealing with wireless telegraphy, the information afforded by the additional matter is of little value. Many of the illustrations, particularly those showing actual apparatus, are of a sketchy type.

The Elements of Illuminating Engineering. By A. P. Trotter. (Pitman's Technical Primers.) Pp. xii+103. (London: Sir I. Pitman and Sons, Ltd., 1921.) 2*s.* 6*d.* net.

THIS booklet contains, in a revised and condensed form, much of the information conveyed in the author's well-known larger volume; some additional practical hints are also included. The initial chapter deals with laws and definitions. The effect of light on vision and the origin of glare are then briefly treated. Next Mr. Trotter passes on to a discussion of the chief sources of light, illustrating the distribution of light in each case and pointing out the fundamental principles involved in effective shading. Finally there are chapters on photometry and the planning of lighting installations. The diagrams are invariably clear and informative, and the explanations are lucid. The author has made good use of the space available, and his work will form a useful introduction to illuminating engineering.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Metallic Coloration of Chrysalids.

I HAVE read Mr. Mallock's letter (NATURE, November 3, p. 302) on iridescent colours with the greatest interest, but I cannot help thinking that in some cases his statements are slightly misleading. Mr. Mallock seems to imply that all the iridescent colours of the animal world are due to some form of interference. It is true that he restricts his statement to the cases he has examined, but it seems safe to assume that if many colours were due to other causes, Mr. Mallock would have met with some of these among the many hundreds of cases investigated during the twenty years in which he has prosecuted his researches.

I cannot lay claim to having carried out such extensive investigations, nor have I the training in physics which gives so much weight to Mr. Mallock's words, nevertheless I venture to urge that the phenomena of insect iridescence (not to speak of the rest of the animal world) include many cases which cannot be brought into the category of interference. These exceptions cannot be described now, but some have appeared in NATURE (September 30, October 7, and October 14, 1920), and a fuller account is to be found in Phil. Trans. Roy. Soc., B, vol. 211, pp. 1–74.

It would be interesting to know how Mr. Mallock explains the colours of the wings of those beetles, bees, and dragon-flies which the late Lord Rayleigh, Prof. Poulton, and myself have found would change colour neither on pressure nor when immersed in fluids under reduced pressure. Such beetles include the rose beetle (*Cetonia aurata*), many Buprestids, and other common insects, some of which Mr. Mallock is sure to have examined. Then there are the golden elytra of *P. resplendens*, which resist pressure and change to magenta on being polished; also the numerous iridescent tortoise beetles, the colour of which not only resists pressure, but even the removal by polishing of the thick surface-layer of chitin without altering its appearance. Among iridescent birds Mandoul has found that peacock's feathers resist pressure, and even hammering on an anvil; the bright-coloured feathers of Cotinga, which Haecker and Meyer attribute to "blue due to the scattering of small particles" by fine canals (*Porencanälen*) in the keratin, would, I presume, not be considered by Mr. Mallock as true iridescent objects.

Finally, there are the beetles to which Biedermann first directed attention (*e.g. H. africana*). Whether or not the cause of their colour is the same as in the last case, sections of the elytra in the plane of the wing are of nearly the same colour as the original beetle. Sections at right angles to the elytra are the same yellowish colour as the chitin.

Mr. Mallock also asserts that the colours of birds and insects are not, as has so often been said, due to diffraction. I admit that I know of no butterfly in which the principal colours are caused in this way, but what of the pale Morphos and other insects which, when the wing is partly turned, exhibit all the colours of the spectrum superimposed on the ground colour? These colours correspond exactly, in appearance and angle, to those of the replica diffraction gratings made in collodion from the wings.

Personally, I am prepared to agree that the wings of almost all iridescent Lepidoptera owe their colours to interference, but it would be interesting to learn Mr. Mallock's reasons for disagreeing with so eminent an authority as Prof. Michelson, who is of the opinion, on purely physical grounds, that all the colours of insects are due to selective metallic reflection, with the exception of the iridescent scale-bearing weevils (*e.g.* the diamond beetle), the colours of which he attributes to diffraction—a cause ruled out by Mr. Mallock.

I have referred only to the colours of insects and birds, but it would be most interesting to know to what forms of structure Mr. Mallock attributes such striking examples of iridescence as are to be found among the hairs of some mammals, the setæ of many marine worms, certain ferns and seeds, and many brilliantly coloured crustacea, some of which Mr. Mallock must surely have examined.

H. ONSLOW.

3 Selwyn Gardens, Cambridge, November 9.

The Softening of Secondary X-rays.

A NUMBER of experimenters have noticed that when a beam of X-rays or γ-rays traverses any substance, the secondary rays excited are less penetrating than the primary rays. Prof. J. A. Gray (Franklin Institute Journal, November, 1920) and the present writer (*Phil. Mag.*, May, 1921, and *Phys. Rev.*, August, 1921) have shown that the greater part of this softening is not due, as was at first supposed, to a greater scattering of the softer components of the primary beam, but rather to a real change in the character of the radiation. My conclusion was that this transformation consisted in the excitation of some fluorescent rays of wave-length slightly greater than that of the primary rays. Prof. Gray, on the other hand, showed that if the primary rays came in thin pulses, as suggested by Stokes's theory of X-rays, and if these rays are scattered by atoms or electrons of dimensions comparable with the thickness of the pulse, the thickness of the scattered pulse will be greater than that of the incident pulse. He accordingly suggests that the observed softening of the secondary rays may be due to the process of scattering.

It is clear that if the X-rays are made to come in long trains, as by reflection from a crystal, the scattering process can effect no change in wave-length. On Gray's view, therefore, if X-rays reflected from a crystal are allowed to traverse a radiator, the incident and the excited rays should both have the same wave-length and the same absorption coefficient. If, on the other hand, the softening is due to the excitation of fluorescent rays, as I had suggested, reflected X-rays should presumably be softened by scattering in the same manner as unreflected rays. An examination of the absorption coefficient of reflected X-rays before and after they have been scattered should therefore afford a crucial test of the two hypotheses.

The double reduction in intensity which occurs when the X-ray beam is first reflected by a crystal and then scattered by the radiator made Gray's preliminary attempts to perform this experiment unsuccessful. In the September (1921) issue of the *Philosophical Magazine*, however, Mr. S. J. Plimpton describes a successful attempt to measure the absorption of the K lines from rhodium and molybdenum after being scattered by paraffin and water. He observed no change in the absorption coefficient of the rays after being scattered by the paraffin. Apparently his measurements were made on the secondary rays at comparatively small angles, and this, together with the relatively long wave-lengths employed, form the conditions under which the least change in hardness occurs when unreflected X-rays are used. I accordingly repeated Mr. Plimpton's

experiments, using the K lines from tungsten (effective $\lambda=0.196$ Å.) reflected from rock-salt, and measured the absorption coefficient of the secondary radiation excited by these rays in paraffin. The absorption coefficient of these rays was found to be considerably greater, by about 52 per cent. at 90° and 22 per cent. at 30°, than that of the beam incident on the paraffin.

In order to compare my results with those of Mr. Plimpton, a molybdenum Coolidge tube was then substituted for the tungsten one, and the K_α line ($\lambda=0.708$ Å.) was employed. An increase in the absorption coefficient of the secondary rays excited in paraffin was again observed, though it amounted to only 29 per cent. at 90° and only 6 ± 1.2 per cent. at 20° with the primary beam.

The softening thus observed when reflected X-rays are scattered is substantially the same as that found when unreflected rays of the same hardness are employed. Mr. Plimpton's negative result is apparently due to the fact that his experiment was performed under unfavourable conditions of wave-length and scattering angle. The conclusion seems necessary, therefore, that the softening of secondary X-rays is due, not to the process of scattering, but to the excitation of a fluorescent radiation in the radiator.

ARTHUR H. COMPTON.
Washington University, St. Louis, U.S.A.

The Colour of the Sea.

THE view has been expressed that "the much-admired dark blue of the deep sea has nothing to do with the colour of water, but is simply the blue of the sky seen by reflection" (Rayleigh's Scientific Papers," vol. 5, p. 540, and NATURE, vol. 83, p. 48, 1910). Whether this is really true is shown to be questionable by a simple mode of observation used by the present writer, in which surface-reflection is eliminated, and the other factors remain the same. The method is to view the surface of the water through a Nicol's prism, which may for convenience be mounted at one end of a tube so that it can be turned about its axis and pointed in any direction. Observing a tolerably smooth patch of water with this held in front of the eye at approximately the polarising angle with the surface of the sea, the reflection of the sky may be quenched by a suitable orientation of the Nicol. Then again, the sky-light on a clear day in certain directions is itself strongly polarised, and an observer standing with his back to the sun when it is fairly high up and viewing the sea will find the light reflected at all incidences sufficiently well polarised to enable it to be weakened or nearly suppressed by the aid of a Nicol.

Observations made in this way in the deeper waters of the Mediterranean and Red Seas showed that the colour, so far from being impoverished by suppression of sky-reflection, was wonderfully improved thereby. A similar effect was noticed, though somewhat less conspicuously, in the Arabian Sea. It was abundantly clear from the observations that the blue colour of the deep sea is a distinct phenomenon in itself, and not merely an effect due to reflected sky-light. When the surface-reflections are suppressed the hue of the water is of such fullness and saturation that the bluest sky in comparison with it seems a dull grey.

By putting a slit at one end of the tube and a grating over the Nicol in front of the eye, the spectrum of the light from the water can be examined. It was found to exhibit a concentration of energy in the region of shorter wave-lengths far more marked than with the bluest sky-light.

Even when the sky was completely overcast the blue of the water could be observed with the aid of a Nicol. It was then a deeper and fuller blue than ever, but of greatly enfeebled intensity. The altered appearance of the sea under a leaden sky must thus be attributed to the fact that the clouds screen the water from the sun's rays rather than to the incidental circumstance that they obscure the blue light of the sky.

Perhaps the most interesting effect observed was that the colour of the water (as seen with the Nicol held at the polarising angle to the surface of the water and quenching the surface-reflection) varied with the *azimuth* of observation relatively to the plane of incidence of the sun's rays on the water. When the plane of observation and the plane of incidence were the same, and the observer had his back to the sun and looked down into the water, the colour was a brilliant, but comparatively lighter, blue. As the plane of observation is swung round the colour becomes a deeper and darker blue, and at the same time decreases in intensity, until finally when the plane of observation has swung through nearly 180° the water appears very dark and of a colour approaching indigo. Both the colour and the intensity also varied with the altitude of the sun.

The dependence of the colour on the azimuth of observation cannot be explained on a simple absorption theory, and must evidently be regarded as a *diffraction* effect arising from the passage of the light through the water. Looking down into the water with a Nicol in front of the eye to cut off the surface-reflections, the track of the sun's rays could be seen entering the water and appearing by virtue of perspective to converge to a point at a considerable depth inside it. The question is: What is it that diffracts the light and makes its passage visible? An interesting possibility that should be considered in this connection is that the diffracting particles may, at least in part, be the *molecules* of the water themselves. As a rough estimate, it was thought that the tracks could be seen to a depth of 100 metres, and that the intensity of the light was about one-sixth of that of the light of the sky from the zenith. If we assume that clear water, owing to its molecular structure, is capable of scattering light eight times as strongly as dust-free air at atmospheric pressure, it is clear that the major part of the observed effect may arise in this way.

It is useful to remember that the reflecting power of water at normal incidence is quite small (only 2 per cent.), and becomes large only for very oblique reflection. It is only when the water is quite smooth and is viewed in a direction nearly parallel to the surface that the reflected sky-light overpowers the light emerging from within the water. In other cases the latter has a chance of asserting itself.

C. V. RAMAN.
S.S. *Narkunda*, Bombay Harbour,
September 26.

The "Proletarisation of Science" in Russia.

DR. H. LYSTER JAMESON asks in NATURE of September 29, p. 147, for an account of the constructive elements of the "proletarisation of science" in Russia, and seems to praise the effort of the Soviet Government to bring the fundamental conclusions of scientific thought within the reach of the "proletariat" by editing a whole series of elementary text-books of natural science.

A Russian university professor, whose friendship I have enjoyed for more than twenty-five years, who has just escaped from the "Bolshevik Paradise," gave

me some information on the point in question which will, no doubt, interest British men of science, whose deep religious feeling I had the opportunity of admiring during the days when I studied in England some forty years ago.

According to this professor's experience, the aim of this "popularisation" of science is to replace the old religion by a new religion—Bolshevism. It is announced to the completely uneducated people that the Old and New Testaments are myths, that God, Creation, and the sublime Christian morals connected with our religion are mere prejudices of the "bourgeois," and that man is only an animal somewhat more developed than the ape, etc.

As regards education in the universities, there are still capable professors teaching who are unable to leave the country, but they have practically no rights, and there is no possibility of free scientific work. The place of the rector of the university to which my friend was attached is occupied by a former demonstrator, "whose only printed matter is his visit card," but he is a trustworthy Bolshevik, just as are the stewards ruling the university.

The only qualification for the teachers in secondary and primary schools is a Bolshevik faith—other qualification is not needed. It is, therefore, easily understood that the teaching of the old religion and morals is abolished from all types of schools.

A translation of Geikie's "Physical Geography" has been known in Russia for some years, but nowadays there are few people whose preliminary scientific education would allow them to read this or a similar work with any profit. My friend also assures me that ostensible editions of the popular scientific books quoted by Dr. Jameson are, to use a household word, "Potemkin's villages," the object of which is to acquire sympathy for Bolshevism among men of science who are far away and unable to witness the charms of this "paradise."

As regards the passage quoted in Dr. Sokoloff's article in NATURE of September 1, 1921, p. 20, which gave rise to the present discussion: "There is Prof. Behtereff, who declares that all Russian men of science now abroad should return to Rusia"—this is fortunately impossible, since, according to the recent "ukaz" of the Soviet Government (see *Rul* of October 14), no Russian is allowed to return to Russia unless he possesses food enough for three or four months.

This challenge was also answered at the meeting of Russian men of science, mostly university professors from all parts of Europe, held last week in Prague, which is to-day the centre of Slavonic scientific culture. Resolutions were accepted at this meeting by which the Russian *savants* who were present organised themselves for permanent scientific work outside their country. Moreover, steps were taken to enable Russian students, with the aid of our Government, to study in our university and in other schools (we know Russian, and they learn Bohemian easily). Surely all this proves that Russian professors are by no means willing to accept Prof. Bechtérev's (or Behtereff's) invitation.

The President of our Republic, Dr. Masaryk, formerly professor of philosophy and sociology in this university, has just published a remarkable article, "Political Anthropomorphism," in which he states that Bolshevik Government placards in Moscow have inscriptions: "Religion is Opium for People." In his opinion the social and political ideal of an uneducated and uncultured ("negramotnyj") Russian mujik (mužik) is to stand on the dunghill and to crack the whip instead of working, and to use it not only on his horses, but also on his fellow-creatures. The President concludes: "The Bolshevik experiment did not succeed, and cannot succeed, because the Bolsheviks, who are not at the level of human culture, succumbed to rude anthropomorphism."

I conclude with the question: What is left now of the *fata Morgana* of Bolshevism? I am very glad that no other Government in the world is following its example.

BOHUSLAV BRAUNER.
Chemical Laboratory, Bohemian University,
Prague, October 20.

Biological Terminology.

DR. BATHER in NATURE of October 27, p. 271, referred Sir Archdall Reid to Prof. Goodrich's presidential address to Section D of the British Association at its Edinburgh meeting this year for a discussion of certain questions, and characterised that address as "clear and thoughtful." It appears to me that Prof. Goodrich had adopted Sir Archdall Reid as his guide and authority in questions of evolution, and it is difficult to understand how the teacher could learn from his pupil. Prof. Goodrich's address ignores the greater part of all the new conceptions and new results obtained by recent research on heredity and genetics. The only recent work of importance which he mentions is that of Guyer on the effect of lens-destroying serum injected into rabbits.

Prof. Goodrich states that the newest characters may be inherited as constantly as the most ancient *provided they are possessed by both parents*, stating in a footnote that he sets aside complications due to Mendelian segregation, which do not bear on the questions at issue. But surely Mendelian segregation bears most fundamentally on the proviso that a character must be possessed by both parents in order to be inherited, since Mendelian researches have shown that a character may be inherited when it is apparent only in one parent or in neither. It may be asked whether "possessed" means "apparent" or not, but the context shows that Prof. Goodrich meant the two terms to be synonymous, since he states that the question, "Why are some characters inherited and others not?" is the same as the question, "Why do some characters reappear in the offspring and others not?" Characters could not reappear in the offspring if they did not appear in the parents. When a person bearing the abnormality brachydactyly marries a normal person, half the children are brachydactylous. Here the character is possessed by only one parent. In many other cases, where the one parent is homozygous for a dominant character which is absent in the other parent, all the offspring show the character. Again, there are cases in which a man with normal sight marries a woman with normal sight, and half the male children are colour-blind. According to Prof. Goodrich's definitions this would not be inheritance at all, but we know it is due to heredity, and that is more important than any arbitrary definition of inheritance. The antlers of stags are normally possessed by one parent only, but they are certainly inherited.

Prof. Goodrich states that inheritance depends on the condition that the germinal factors and the environmental conditions which co-operated in the formation of a character in the ancestor should both be present. Suppose we consider the case of an albino. What are the environmental conditions which co-operated in the formation of this character? The fact is that a new character or a change of character may be due *either* to an alteration of the germinal factors *or* of the environmental conditions. In the former

case the variation or mutation is produced without any change of environment, and often persists under a great range of difference in environment. We call such a change due to difference in germinal factors a mutation or congenital variation, a change due to environment or modification an acquired character. Therefore, to assert, as Prof. Goodrich and Sir Archdall Reid do, that all characters are acquired during the lifetime of the individual is a misuse of terms, and tends to confuse and obscure a perfectly clear distinction. Characters due to genetic factors are developed, not acquired; characters due to environmental change without change of genetic factors are acquired.

Prof. Goodrich states that in an environment which, on the whole, alters but little, evolution progresses by the cumulation, along diverging lines of adaptation, of new characters due to mutation. I regret to have to disagree fundamentally with a zoologist for whose work in his own special field I have so great a respect, but my own studies have led me to the conclusion that this statement is not in accordance with our present knowledge. What we know of mutation and adaptation seems to me to indicate very strongly that they have nothing whatever to do with each other.

J. T. CUNNINGHAM.

University of London Club, 21 Gower Street,
November 2.

Reflection "Halo" of (Semi-)Cylindrical Surfaces.

I RECENTLY noticed on the wall of a staircase in this college a clear ring of light, produced by a low sun shining through an open window. The ring was free from colour, circular so far as could be judged by eye, and complete except towards the bottom, where it was cut across by the shadow of a polished wooden handrail. A little investigation showed that the appearance was due to the reflection of sunlight falling on this rail, the upper surface of which is more or less cylindrical. Sighting along the rail showed that the axis of this cylinder passed approximately through the centre of the ring. The phenomenon must have been observed often enough, but I have not seen it described. It is readily treated by simple geometrical methods as follows:—

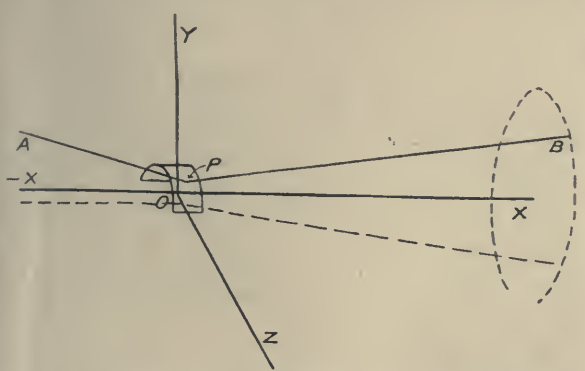

FIG. 1.—AP=incident ray; PB=reflected ray. Broken lines are projections on XZ plane of these rays; broken ring shows form of "halo" on a screen parallel to the YZ plane.

Let the reflecting segment of cylinder considered have its centre at the origin, and let its radius be r and its axis that of X (Fig. 1). Let an incident ray AP parallel to the XY plane fall, from the −X direction, on the point $P(o,y_0,z_0)$ of the cylinder; the equations of the ray may then be written $y+mx=y_0$, $z=z_0$. The normal at P is $z_0y=y_0z$, and the perpendicular plane through the origin is $y_0y+z_0z=0$. The incident and reflected rays must cut this plane in two points, the join of which is bisected by the origin. The incident ray meets it at

$$\left(y_0+\frac{z_0^2}{y_0}\Big/m,\ -z_0^2\Big/y,\ z_0\right),$$

so the point with equal and opposite co-ordinates must lie on the reflected ray; so does $P(o,y_0,z_0)$. Hence the reflected ray is given by

$$my_0x\Big/\left(y_0^2+z_0^2\right)=\left(y-y_0\right)\Big/\left(y_0-\frac{z_0^2}{y_0}\right)=\left(z-z_0\right)\Big/2z_0.$$

From this it follows at once that $(y-y_0)^2+(z-z_0)^2=m^2x^2$. Thus, considering all values of y_0 and z_0, we see that so long as y_0 and z_0 are small compared with x, y, z, the reflected light is practically a right cone, with its axis along that of the cylinder. The distribution of brightness and other points can easily be worked out, but would make this note unduly long.

The phenomenon is shown by any reflecting cylinder; a nickelled shaving-soap tin answers admirably. The radius of the ring thrown on a screen normal to the axis is readily shown to be practically independent of the diameter of the cylinder, but proportional to the tangent of the angle between the incident rays and the axis, as the final equation shows. The ring stops at $z=\pm r$ on the −Y axis—*i.e.* appears to be cut across by the shadow of the cylinder. Increase of length of the cylinder, of course, results in a widening of the ring.

J. H. SHAXBY.

University College of South Wales and
Monmouthshire, Cathays Park, Cardiff,
October 31.

Microscope Illumination and Fatigue.

A VERY large part of the fatigue produced by working at the microscope for long hours is due to the use of incorrectly adjusted illumination, whether too bright or too weak. In routine work of a critical nature, where daylight is out of the question for several reasons and an artificial light source must be used, the light may be regulated so as to be satisfactory for the combination of eyepiece and objective most frequently used, but any change of either materially alters the brilliancy of the field. Any alteration of the substage to correct for this will upset the critical adjustment of the optical system; the changing of light-filters is a rough-and-ready solution, but fine differences cannot easily be made without varying the quality of the light, and, in most cases, require the removal of the eye from the microscope to carry out.

When working with a 30-c.p. "Pointolite" lamp (which provides the ideal homogeneous source of light, and with a suitable condenser and monochromatic filter gives more than enough light for any combination), it was found that the excess of light was very tiring to the eyes, and the manipulation of extra filters for each change of eyepiece or objective involved a great loss of time. It seemed possible that the pyrometric lamp advertised by the same makers might produce better results, as the candle-power can be varied between very wide limits; but before trying it experiments were made with the 30-c.p. lamp.

It was found that by inserting extra resistance into the arc circuit (which in this case was some 350 ohms) the light may be varied from full to a dull red glow,

or practically zero when a monochromatic blue or green filter is used. The only precaution necessary is to cut out the extra resistance when starting up, as the arc tends to strike on to the ioniser spiral.

By using a sliding resistance of 800 ohms (suitably protected) fastened to the bench near the microscope, where it can be found and adjusted without moving the head from the eyepiece, complete control over the lighting is obtained, and the optimum intensity for any combination of any eyepiece, objective, condenser, and light-filter becomes possible with fully critical illumination.

Apart from the reduction of optical fatigue, the system has the further advantage of rendering fine detail more easily visible, and in cytological work the achromatic structures are much plainer. When working with the Abbe drawing apparatus the difficulty of balancing the illumination of the field and the drawing surface is eliminated.

There is nothing new in the use of a resistance with an electric lamp for microscope work, but users of "Pointolites," with all their advantages over other types, may be interested to know that such control is feasible.

H. J. DENHAM.

Botanical Laboratory, British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester, November 11.

The Aurora Borealis of September 28–29.

WITH reference to my letter in NATURE of October 6 on the observation of the aurora on the night of September 28–29 and Father Cortie's record of the accompanying magnetic storm (NATURE, October 27), I have just received a communication from Mr. J. W. Young, of Glasgow, a portion of which may be of interest in the above connection :—

"It may interest you to know that by my records I find I also saw this. The back of my house (on south-west of Glasgow) gives me a clear view of some twenty miles along the Loch Lomond valley in the direction of magnetic north, and for some years it has been my practice to keep watch for such occurrences, much more frequent here than most are aware. Usually 8–11 p.m. is the period of greatest brilliancy, and the streams of yellow, pink, and green light sometimes extend, pulsating, almost to the zenith. . . ."

WILLIAM J. S. LOCKYER.

Norman Lockyer Observatory, Salcombe Hill, Sidmouth, S. Devon, November 7.

Applied Anthropology.

I WAS, unfortunately, unable to take part in the discussion on a possible Anthropological Service at Edinburgh, referred to in the leading article in NATURE of November 10, but there is one point on which I would have insisted had I been present: the danger of a little knowledge. Anthropology is fundamentally a branch of biology, not of literature or philosophy, except in so far as the latter is biological. It is, perhaps, the most complicated of all the branches of biology, and the branch in which the collection of precise data is the most difficult. To me it is inconceivable that a sound knowledge of anthropology can be obtained without a preliminary training in biological method. At present anthropological study, especially that of the physical or anatomical side, is in a state of chaos, largely because the comparative student has to make use of information of all degrees of accuracy or the reverse—mostly the reverse. What a missionary said two hundred years ago may carry greater weight than a recent investigation on sound scientific lines.

My own investigations in the Malay Peninsula and my more recent experience as a Government official in India have taught me the disadvantages under which an official labours in collecting anthropological information, and I think that most scientific men in the employment of any Government would agree with me in their hearts that there is no danger more to be feared in scientific administration than the interference of the administrative officer who possesses, or is led to think he possesses, a peculiar, but superficial, knowledge of any branch of science.

If anthropology is a branch of science, or rather, as I believe, a complex of the terminal twigs of several distinct branches, it must be studied seriously and scientifically, not merely tacked on as a kind of floral decoration to a classical or commercial education.

N. ANNANDALE.

Abden House, Marchhall Crescent, Edinburgh, November 11.

Use of Carborundum for Ruling Test Plates.

THE communication from Mr. A. Mallock in NATURE of September 1, p. 10, reminds me of the marked success that I have had in the use of fine carborundum points for scratching on glass. Some years ago, when confronted with the task of preparing small oscillograph mirrors from microscope cover-glasses, I found that a small fragment of carborundum crystal tied in the split end of a match or forced into a piece of soft rubber for a handle made an excellent glass-cutter. The scratches were so fine and clean-cut that the glass could easily be broken into very narrow strips.

Although very hard and sharp, the points are wide-angled, the angles as viewed in a microscope appearing to be in the neighbourhood of 90°.

It seems possible that these crystals, if the pressure were sufficiently light, might be used to rule lines on thin films of aniline colours without scratching the glass.

W. G. CADY.

Wesleyan University, Middletown, Conn., October 22.

Bee-sting and Eyesight.

I WAS stung in my left eye by a bee yesterday just above the eyelid. Within an hour and a half that eye became almost insensitive to light, but quickly recovered. In the first stage of recovery it was practically colour-blind, and when the other eye was closed objects appeared as seen by the light of a sodium flame or a mercury arc light. To-day the eye has fully recovered. I am wondering whether other of your readers can record a similar experience.

J. W. GIFFORD.

Oak'ands, Chard, October 21.

The Age of the Earth.

WITH regard to Lord Rayleigh's letter (NATURE, November 10), I think my use of the word "suggestion," instead of "statement," for example, sufficiently indicated that I appreciated the fact that he did not definitely assert that the earth was becoming hotter. I am glad to find that his views and mine are not in essential disagreement.

HAROLD JEFFREYS.

Meteorological Office, South Kensington, London, S.W.7, November 15.

A New Cave Man from Rhodesia, South Africa.

By DR. ARTHUR SMITH WOODWARD, F.R.S.

DURING recent years the British Museum has received from the Rhodesia Broken Hill Development Co. numerous bones from a cave discovered in their mine in North-west Rhodesia about 150 miles north of the Kafue river. All except the smaller of these bones are merely broken fragments, and they evidently represent the food of men and flesh-eating mammals who have at different times occupied the cave. As described by Mr. Franklin White (Proc. Rhodesia Sci. Assoc., vol. 7, p. 13, 1908) and Mr. F. P. Mennell (*Geological Magazine* [5], vol. 4, p. 443, 1907), rude stone and bone implements are abundant among the remains, and there can be no doubt that the cave was a human habitation for a long period. Very few of the bones can be exactly named, but, so far as they have been identified by Dr. C. W. Andrews and Mr. E. C. Chubb, they belong to species still living in Rhodesia or to others only slightly different from these. The occupation of the cave, therefore, seems to have been at no distant date—it may not even have been so remote as the Pleistocene period.

Until lately no remains of the cave man himself have been noticed at Broken Hill, but at the end of last summer Mr. W. E. Barren was so fortunate as to discover and dig out of the earth in a remote part of the cave a nearly complete human skull, a fragment of the upper jaw of another, a sacrum, a tibia, and the two ends of a femur. These specimens have just been brought to England by Mr. Ross Macartney, the managing director of the company, and they are to be added to the many generous gifts of the company to the British Museum.

The skull is in a remarkably fresh state of preservation, the bone having merely lost its animal matter and not having been in the least mineralised. As shown in the accompanying photograph, it is strangely similar to the skull of the Neanderthal or Mousterian race found in the caves of Belgium, France, and Gibraltar. Its brain-case is typically human, with a wall no thicker than that of the average European, and its capacity, though still not determined, is obviously well above the lower human limit. Its large and heavy face is even more simian in appearance than that of Neanderthal man, the great inflated brow-ridges being especially prominent and prolonged to a greater extent at the lateral angles.

The roof of the skull at first sight appears remarkably similar to that of Pithecanthropus from Java, having the same slight median longitudinal ridge along the frontals and rising to its greatest height just about the coronal suture. It is, however, very much larger, and the resemblance may not imply any close affinity. The length of the skull from the middle of the glabella to the inion is about 210 mm., while its maximum width at the parietal bosses is 145 mm. The skull is therefore dolichocephalic, with a cephalic index of 69. Its greatest height (measured from the basion to the bregma) is 131 mm. In general shape the brain-case is much more ordinarily human than that of the La Chapelle Neanderthal skull, which differs in the expansion and bun-shaped depression of its hinder region. The mastoid process, though human, is comparatively small. The supramastoid ridge is very prominent and broad. The tympanic meatus is short and broad, as always in man. The foramen magnum occupies its usual forward position, so that the skull would be perfectly poised on an erect trunk.

The facial bones much resemble those of the La Chapelle skull, the great flat maxillaries, without canine fossæ, being especially similar. The nasal bones, however, are more gently sloping; the sharp lateral edge of the narial opening runs down on the face (as in the gorilla), allowing the

premaxillary surface to pass uninterruptedly into the floor of the narial cavity; and the infranasal region is unusually deep. The typically human anterior nasal spine is conspicuous.

The palate is of enormous size, as large as that inferred by Boule from the fragments preserved in the La Chapelle skull. It is, however, in all respects human, being deeply arched and bounded by the horse-shoe-shaped row of teeth, which are unusually large, but also entirely human. The teeth are much worn, and those of the front of the jaw met their lower opposing teeth in the primitive way, edge to edge. The canines are not enlarged. The second molar is square, 13·5 mm. in diameter. The third molar is much reduced, measuring 12·5 mm. in width by 9·5 mm. in length. The total length of the molar series is about 33 mm. The outside measurement of the dentition across the second molars is 78 mm. The width between the sockets of the third molars

is 51 mm. The length from the socket of the median incisor to a line drawn across the back of the third molars is also 51 mm. The whole dentition is much affected with caries, and the disease has spread to the tooth-sockets, which are pierced in some places.

The lower jaw is unfortunately absent, but the size of the palate and the extent of the temporal fossæ show that it must have been massive. Even the Heidelberg jaw is slightly narrower and shorter than this must have been.

Although the new skull from the Rhodesian cave so much resembles that of Neanderthal man, the shape of the brain-case and the position of the foramen magnum are so different that we may hesitate to refer the two skulls to the same race. This hesitation seems to be justified when the associated limb-bones are considered, for the tibia is long and slender, of the typically modern type, and the extremities of the femur do not differ in any essential respect from the corresponding parts of a tall and robust modern man. They are thus very different from the tibia and femur of Neanderthal man found in the caves of Belgium and France. As the skull appears to postulate an erect attitude, the congruous limb-bones may well be referred to it. We therefore recognise in the Rhodesian cave man a new form which may be regarded as specifically distinct from *Homo neanderthalensis*, and may be appropriately named *Homo rhodesiensis*.

The precise systematic position of this new species of primitive man can be determined only by further discoveries. It has, however, been pointed out by Prof. Elliot Smith that the refinement of the face was probably the last step in the evolution of the human frame. The newly discovered Rhodesian man may therefore revive the idea that Neanderthal man is truly an ancestor of *Homo sapiens*; for *Homo rhodesiensis* retains an almost Neanderthal face in association with a more modern brain-case and an up-to-date skeleton. He may prove to be the next grade after Neanderthal in the ascending series.

Problems of Physics.[1]

By PROF. O. W. RICHARDSON, D.Sc., F.R.S.

RELATIVITY is the revolutionary movement in physics which has caught the public eye, perhaps because it deals with familiar conceptions in a manner which for the most part is found pleasantly incomprehensible. But it is only one of a number of revolutionary changes of comparable magnitude. Among these we have to place the advent of the quantum. The various consequences of the electronic structure of matter are still unfolding themselves to us, and are increasing our insight into the most varied phenomena at a rate which must have appeared incredible only a few decades ago.

The enormous and far-reaching importance of the discoveries being made at Cambridge by Sir Ernest Rutherford cannot be over-emphasised. These epoch-making discoveries relate to the structure and properties of the nuclei of atoms. At the present time we have, I think, to accept it as a fact that the atoms consist of a positively charged nucleus of minute size, surrounded at a fairly respectful distance by the number of electrons requisite to maintain the structure electrically neutral. The nucleus contains all but about one-two-thousandth part of the mass of the atom, and its electric charge is numerically equal to that of the negative electron multiplied by what is called the atomic number of the atom, the atomic number being the number which is obtained when the chemical elements are enumerated in the order of the atomic weights; thus hydrogen = 1, helium = 2, lithium = 3, and so on. Consequently the number of external electrons in the atom is also equal to the atomic number. The evidence, derived from many distinct and dissimilar lines of inquiry, which makes it necessary to accept the foregoing statements as facts, will be familiar to members of this Section of the British Association, which has continually been in the forefront of contemporary advances in physical science.

The diameters of the nuclei of the atoms are comparable with one-millionth of one-millionth part of a centimetre, and the problem of finding what lies within the interior of such a structure seems at first sight almost hopeless. It is to this problem which Rutherford has addressed himself by the direct method of bombarding the nuclei of the different atoms with the equally minute high-velocity helium nuclei (alpha-particles) given off by radioactive substances, and examining the tracks of any other particles which may be generated as a result of the impact. A careful and critical examination of the results shows that hydrogen nuclei are thus expelled from the nuclei of a number of atoms such as nitrogen and phosphorus. On the other hand, oxygen and carbon do not eject hydrogen under these circumstances, although there is evidence in the case of oxygen and nitrogen of the expulsion of other sub-nuclei whose precise structure is a matter for further inquiry.

The artificial transmutation of the chemical elements is thus an established fact. The natural transmutation has, of course, been familiar for some years to students of radio-activity. The philosopher's stone, one of the alleged chimeras of the mediæval alchemists, is thus within our reach. But this is only part of the story. It appears that in some cases the kinetic energy of the ejected fragments is greater than that of the bombarding particles. This means that these bombardments are able to release the energy which is stored in the nuclei of atoms. Now, we

[1] Abridged from the presidential address delivered to Section A (Mathematics and Physics) of the British Association at Edinburgh on September 9.

know from the amount of heat liberated in radio-active disintegration that the amount of energy stored in the nuclei is of a higher order of magnitude altogether, some millions of times greater, in fact, than that generated by any chemical reaction such as the combustion of coal. In this comparison, of course, it is the amount of energy per unit mass of reacting or disintegrating matter which is under consideration. The amounts of energy which have thus far been released by artificial disintegration of the nuclei are in themselves small, but they are enormous in comparison with the minute amounts of matter affected. If these effects can be sufficiently intensified there appear to be two possibilities. Either they will prove uncontrollable, which would presumably spell the end of all things,[2] or they will not. If they can be both intensified and controlled then we shall have at our disposal an almost illimitable supply of power which will entirely transcend anything hitherto known. It is too early yet to say whether the necessary conditions are capable of being realised in practice, but I see no elements in the problem which would justify us in denying the possibility of this. It may be that we are at the beginning of a new age, which will be referred to as the age of sub-atomic power. We cannot say; time alone will tell.

Thermionic Emission.

At the Manchester meeting of the Association in 1915 I had the privilege of opening a discussion on thermionic emission—that is to say, the emission of electrons and ions by incandescent bodies. I recall that the opinion was expressed by some of the speakers that these phenomena had a chemical origin. That view, I venture to think, is one which would find very few supporters now. It is not that any new body of fact has arisen in the meantime. The important facts were all established before that time, but they were insufficiently appreciated, and their decisiveness was inadequately realised.

It may be worth while to revert for a moment to the issues in that controversy, already moribund in 1915, because it has been closely paralleled by similar controversies relating to two other groups of phenomena—namely, photo-electric emission and contact electro-motive force—which, as we shall see, are intimately connected with thermionic emission. The issue was not as to whether thermionic emission may be looked upon simply as a type of chemical reaction. Such an issue would have been largely a matter of nomenclature. Thermionic electron emission has many features in common with a typical reversible chemical reaction such as the dissociation of calcium carbonate into lime and carbon dioxide. There is a good deal to be said for the point of view which regards thermionic emission as an example of the simplest kind of reversible chemical action, namely, that kind which consists in the dissociation of a neutral atom into a positive residue and a negative electron, inasmuch as we know that the negative electron is one of the really fundamental elements out of which matter is built up. The issue in debate was, however, of a different character. It was suggested that the phenomenon was not primarily an emission of electrons from the metallic or other source, but was a secondary phenomenon, a kind of by-product of an action which was primarily a chemical reaction between the source of electrons and some other material substance such as the highly attenuated gaseous atmosphere which surrounded it. This suggestion carried with it either implicitly or explicitly the view that the source of power behind the emission was not the thermal energy of the source, but was the chemical energy of the postulated reactions.

This type of view has never had any success in elucidating the phenomena, and I do not feel it necessary at this date to weary you with a recital of the facts which run entirely counter to it, and, in fact, definitely exclude it as a possibility. They have been set forth at length elsewhere on more than one occasion. I shall take it to be established that the phenomenon is physical in its origin and reversible in its operation.

Establishing the primary character of the phenomenon does not, however, determine its nature or its immediate cause. Originally I regarded it as simply kinetic, a manifestation of the fact that as the temperature rose the kinetic energy of some of the electrons would begin to exceed the work of the forces by which they are attracted to the parent substance. With this statement there is, I think, no room for anyone to quarrel, but it is permissible to inquire how the escaping electrons obtain the necessary energy. One answer is that the electrons have it already in the interior of the substance by virtue of their energy of thermal agitation. But thermal agitations now appear less simple than they used to be regarded, and in any event they do not exhaust the possibilities.

We know that when light of short enough wave-length falls on matter it causes the ejection of electrons from it—the so-called photo-electric effect. Since the formula for the radiation emitted by a body at any given temperature contains every wave-length without limitation, there must be some emission of electrons from an incandescent body as the result of the photo-electric effect of its own luminosity. Two questions obviously put themselves. Will this photo-electric emission caused by the whole spectrum of the hot body vary as the temperature of the incandescent body is raised in the way which is known to characterise thermionic emission? A straightforward thermodynamic calculation shows that this is to be expected from the theoretical point of view, and the anticipation has been confirmed by the experiments of Prof. W. Wilson. Thus the autophoto-electric emission has the correct behaviour to account for the thermionic emission. The other question is: Is it large enough? This

[2] To reassure the nervous I would, however, interpolate the comforting thought that this planet has held considerable quantities of radio-active matter for a very long time without anything very serious happening so far as we know.

is a question of fact. I have considered the data very carefully. There is a little uncertainty in some of the items, but when every allowance is made there seems no escape from the conclusion that the photo-electric effect of the whole spectrum is far too small to account for thermionic emission.

This question is an important one, apart from the particular case of thermionic emission. The same dilemma is met with when we seek for the actual *modus operandi* of evaporation, chemical action, and a number of other phenomena. These, so far as we know, might be fundamentally either kinetic or photochemical or a mixture of both. (I am using the term photochemical here in the wide sense of an effect of light in changing the composition of matter, whether the parts affected are atoms, groups of atoms, ions, or electrons.) For example, the approximation about boiling points known as Trouton's rule is a fairly obvious deduction from the photochemical point of view. The photochemical point of view has recently been put very strongly by Perrin, who would make it the entire *motif* of all chemical reaction, as well as of radio-activity and changes of state. In view of the rather minor part it seems to play in thermionic emission, where one would *a priori* have expected light to be especially effective, this is probably claiming too much for it, but the chemical evidence contains one item which is certainly difficult to comprehend from the kinetic point of view. The speed of chemical decomposition of certain gases is independent of their volume, showing that the decomposition is not due to molecular collisions. The speed does, however, increase very rapidly with rising temperature. What the increased temperature can do except increase the number and intensity of the collisions, factors which the independence of volume at constant temperature show to be without effect, and increase the amount of radiation received by the molecules, is not too obvious. It seems, however, that, according to calculations by Langmuir (Journ. Amer. Chem. Soc., vol. 42, p. 2190, 1920), the radiation theory does not get us out of this difficulty; for, just as in the ordinary photoelectric case, there is nothing like enough radiation to account for the observed effects. It seems that in the case of these mono-molecular reactions the phenomena cannot be accounted for either by simple collisions, or by radiation, or by a mixture of both, and it is necessary to fall back on the internal structure of the decomposing molecule. This is complex enough to afford material sufficient to cover the possibilities; but, from the point of view of the temperature energy relations of its parts, it cannot at present be regarded as much more than a field for speculation.

Contact Electricity.

A controversy about the nature of the contact potential difference between two metals, similar to that to which I have referred in connection with thermionic emission, has existed for over a century. In 1792 Volta wrote: "The metals . . . can by themselves, and of their own proper virtue, excite and dislodge the electric fluid from its state of rest." The contrary position that the electrical manifestations are inseparably connected with chemical action was developed a few years later by Fabroni. Since that time electrical investigators have been fairly evenly divided between these two opposing camps. Among the supporters of the intrinsic or contact view of the type of Volta we may recall Davy, Helmholtz, and Kelvin. On the other side we have to place Maxwell, Lodge, and Ostwald. In 1862 we find Lord Kelvin ("Papers on Electrostatics and Magnetism," p. 318) writing: "For nearly two years I have felt quite sure that the proper explanation of voltaic action in the common voltaic arrangement is very near Volta's, which fell into discredit because Volta or his followers neglected the principle of the conservation of force." On the other hand, in 1896 we find Ostwald ("Elektrochemie, Ihre Geschichte und Lehre," Leipzig, 1896, p. 65) referring to Volta's views as the origin of the most far-reaching error in electrochemistry, which the greatest part of the scientific work in that domain has been occupied in fighting almost ever since. These are cited merely as representative specimens of the opinions of the protagonists.

Now, there is a close connection between thermionic emission and contact potential difference, and I believe that a study of thermionic emission is going to settle this little dispute. In fact, I rather think it has already settled it, but before going into that matter I would like to explain how it is that there is a connection between thermionic emission and contact potential difference, and what the nature of that connection is.

Imagine a vacuous enclosure, either impervious to heat or maintained at a constant temperature. Let the enclosure contain two different electron-emitting bodies, A and B. Let one of these, say A, have the power of emitting electrons faster than the other, B. Since they are each receiving as well as emitting electrons, A will acquire a positive and B a negative charge under these circumstances. Owing to these opposite charges A and B will now attract each other, and useful work can be obtained by letting them come in contact. After the charges on A and B have been discharged by bringing them in contact, let the bodies be quickly separated and moved to their original positions. This need involve no expenditure of work, as the charges arising from the electron emission will not have had time to develop. After the charges have had time to develop the bodies can again be permitted to move together under their mutual attraction, and so the cycle can be continued an indefinite number of times. In this way we have succeeded in imagining a device which will convert all the heat energy from a source at a uniform temperature into useful work.

Now, the existence of such a device would contravene the second law of thermodynamics. We are therefore compelled either to deny the principles of thermodynamics or to admit that there is some fallacy as to the pretended facts in

the foregoing argument. We do not need to hesitate between these alternatives, and we need only look to see how the alleged behaviour of A and B will need to be modified in order that no useful work may appear. There are two alternatives. Either A and B necessarily emit equal numbers of electrons at all temperatures, or the charges which develop owing to the unequal rate of emission are not discharged, even to the slightest degree, when the two bodies are placed in contact.

The first alternative is definitely excluded by the experimental evidence, so I shall proceed to interpret the second. It means that bodies have natural states of electrification whereby they become charged to definite potential differences whose magnitudes are independent of their relative positions. There is an intrinsic potential difference between A and B, which is the same, at a given temperature, whether they are at a distance apart or in contact.

Admitting that the intrinsic potentials exist, a straightforward calculation shows that they are intimately connected with the magnitudes of the thermionic emission at a given temperature. The relation is, in fact, governed by the following equation. If A and B denote the saturation thermionic currents per unit area of the bodies A and B respectively, and V is the contact potential difference between them at the absolute temperature T, then $V = kT/e \log A/B$, where k is the gas constant calculated for a single molecule (Boltzmann's constant), and e is the electronic charge.

I have recently, with the help of Mr. F. S. Robertson, obtained a good deal of new information on this question from the experimental side. We have made measurements of the contact potential difference between heated filaments and a surrounding metallic cylinder, both under the high-vacuum and gas-free conditions which are now attainable in such apparatus, and also when small known pressures of pure hydrogen are present. As is well known, both contact potentials and thermionic emission are very susceptible to minute traces of gas, but we find that under the best conditions as to freedom from gas there is a contact potential of the order of one volt between a pure tungsten filament and a thoriated filament. We also find that changes of a similar magnitude in the contact potential difference between a thoriated tungsten filament and a copper anode take place when the filament is heated. These changes are accompanied by simultaneous changes in the thermionic currents from the filament, and we find that the change in the contact potential calculated from the change in the currents with the help of the foregoing equation is within about 20 per cent. of the measured value. Considering the experimental difficulties, this is a very substantial agreement. Whilst the evidence is not yet as complete as I hope to make it, it goes a long way towards disproving the chemical view of the origin of contact potential difference.

From what has been said you will realise that the connection between contact potentials and thermionic emissions is a very close one. I would, however, like to spend a moment in developing it from another angle. To account for the facts of thermionic emission it is necessary to assume that the potential energy of an electron in the space just outside the emitter is greater than that inside by a definite amount, which we may call w. The existence of this w, which measures the work done when an electron escapes from the emitter, is required by the electron-atomic structure of matter and of electricity. Its value can be deduced from the temperature variation of thermionic emission, and, more directly, from the latent heats absorbed or generated when electrons flow out of or into matter. These three methods give values of w which, allowing for the somewhat considerable experimental difficulties, are in fair agreement for any particular emitter. The data also show that in general different substances have different values of w. This being so, it is clear that when uncharged bodies are placed in contact the potential energies of the electrons in one will in general be different from those of the electrons in the other. If, as in the case of the metals, the electrons are able to move freely they will so move until an electric field is set up which equilibrates this difference of potential energy. There will thus be an intrinsic or contact difference of potential between metals which is equivalent to the difference in the values of w and is equal to the difference in w divided by the electronic charge.[3]

Photo-electric Action.

We have seen that there is a connection on broad lines between thermionic emission and both contact potentials on one hand and photo-electric emission on the other. The three groups of phenomena are also related in detail and to an extent which up to the present has not been completely explored. In order to understand the present position, let us review briefly some of the laws of photo-electric action as they have revealed themselves by experiments on the electrons emitted from metals when illuminated by visible and ultra-violet light.

Perhaps the most striking feature of photoelectric action is the existence of what has been called the threshold frequency. For each metal whose surface is in a definite state there is a definite frequency n_0, which may be said to determine the entire photo-electric behaviour of the metal. The basic property of the threshold frequency n_0 is this: When the metal is illuminated by light of frequency less than n_0 no electrons are emitted, no matter how intense the light may be. On the other hand, illumination by the most feeble light of frequency greater than n_0 causes some emission. The frequency n_0 signalises a sharp and absolute discontinuity in the phenomena.

Now let us inquire as to the kinetic energy of the electrons which are emitted by a metal when illuminated by monochromatic light of frequency,

[3] This statement is only approximately true. In order to condense the argument certain small effects connected with the Peltier effect at the junction between the metals have been left out of consideration.

let us say, n. Owing to the fact that the emitted electrons may originate from different depths in the metal, and may undergo collisions at irregular intervals, it is only the maximum kinetic energy of those which escape which we should expect to exhibit simple properties. As a matter of fact, it is found that the maximum kinetic energy is equal to the difference between the actual frequency n and the threshold frequency n_0 multiplied by Planck's constant h. In mathematical symbols, if v is the velocity of the fastest emitted electron, m its mass, e its charge, and V the opposing potential required to bring it to rest,

$$eV = \tfrac{1}{2}\ m\ v^2 = h\ (n - n_0).$$

From this equation we see that the threshold frequency has another property. It is evidently that frequency for which kinetic energy and stopping potential fall to zero. This suggests strongly, I think, that the reason the electron emission ceases at n_0 is that the electrons are not able to get enough energy from the light to escape from the metal, and not that they are unable to get any energy from the light.

The threshold frequencies have another simple property. If we measure the threshold frequencies for any pair of metals, and at the same time we measure the contact difference of potential K between them, we find that K is equal to the difference between their threshold frequencies multiplied by this same constant h divided by the electronic charge e.

These results, as well as others which I have not time to enumerate, admit of a very simple interpretation if we assume that when illuminated by light of frequency n the electrons individually acquire an amount of energy hn. We have seen that in order to account for thermionic phenomena it is necessary to assume that the electrons have to do a certain amount of work w to get away from the emitter. There is no reason to suppose that photo-electrically emitted electrons can avoid this necessity. Let us suppose that this work is also definite for the photoelectric electrons and let us denote its value by hn_0. Then no electron will be able to escape from the metal until it is able to acquire an amount of energy at least equal to hn_0 from the light—that is to say, under the suppositions made—until n becomes at least as great as n_0. Thus n_0 will be identical with the frequency which we have called the threshold frequency, and the maximum energy of any electron after escaping will be $h\ (n - n_0)$.

The relation between threshold frequencies and contact potential difference raises another issue. We have seen that the contact potential difference between two metals must be very nearly equal to the difference between the amounts of work w for the electrons to get away from the two metals by thermionic action, divided by the electronic charge e. The photo-electric experiments show that the contact electromotive force is also nearly equal to the differences of the threshold frequencies multiplied by h/e. It follows that the photo-electric work hn_0 must be equal to the thermionic work w to the same degree of accuracy. The photoelectric and thermionic works are known to agree to within about one volt. To decide how far they are identical needs better experimental evidence than we have at present. The indirect evidence for their substantial identity is stronger at the moment than the direct evidence.

I do not think that the complete identity of the thermionic work w and the photo-electric hn_0 is a matter which can be inferred *a priori*. What we should expect depends to a considerable extent on the condition of the electrons in the interior of metals. We cannot pretend to any real knowledge of this at present; the various current theories are mere guesswork. Unless the electrons which escape all have the same energy when inside the metal we should expect the thermionic value to be an average taken over those which get out. The photo-electric value, on the other hand, should be the minimum pertaining to those internal electrons which have most energy. The apparent sharpness of the threshold frequency is also surprising from some points of view. There seems to be scope for a fuller experimental examination of these questions.

I have spoken of the threshold frequency as though it were a perfectly definite quantity. No doubt it is when the condition of the body is or can be definitely specified, but it is extraordinarily sensitive to minute changes in the conditions of the surface, such as may be caused, for example, by the presence of extremely attenuated films of foreign matter. For this reason we should accept with a certain degree of reserve statements which appear from time to time that photo-electric action is some parasitic phenomenon, inasmuch as it can be made to disappear by improvement of vacuum or other change in the conditions. What has generally happened in these investigations is that something has been done to the illuminated surface which has raised its threshold frequency above that of the shortest wave-length in the light employed in the test. Unless they are accompanied by specific information about the changes which have taken place in the threshold frequency, such statements are of little value at the present stage of development of this subject.

Light and X-rays.

One of the great achievements of experimental physics in recent years has been the demonstration of the essential unity of X-rays and ordinary light. X-rays have been shown to be merely light of particularly high frequency or short wave-length, the distinction between the two being one of degree rather than of kind. The foundations of our knowledge of X-ray phenomena were laid by Barkla, but the discovery and development of the crystal diffraction methods by v. Laue, the Braggs, Moseley, Duane, and de Broglie have established their relations with ordinary light so

clearly that he who runs may read their substantial identity. The actual gap in the spectrum of the known radiations between light and X-rays is also rapidly disappearing. The longest stride into the region beyond the ultra-violet was made by Lyman with the vacuum grating spectroscope which he developed. For a time Prof. Bazzoni and I held the record in this direction with our determination of the short wave limit of the helium spectrum, which is in the neighbourhood of 450 Angstrom units. More recently this has been passed by Millikan, who has mapped a number of lines extending to about 200 Angstrom units—that is to say, more than four octaves above the violet limit of the visible spectrum. I am not sure what is the longest X-ray which has been measured, but I find a record of a Zinc L-ray by Friman (*Phil. Mag.*, vol. 32, p. 494, 1916) of a wave-length of 12·346 Angstrom units. There is thus at most a matter of about four octaves still to be explored. In approaching this unknown region from the violet end the most characteristic property of the radiations appears to be their intense absorption by practically every kind of matter. This result is not very surprising from the quantum point of view. The quantum of these radiations is in excess of that which corresponds to the ionising potential of every known molecule, but it is of the same order of magnitude. Furthermore, it is large enough to reach not only the most superficial, but also a number of the deeper-seated electrons of the atoms. There is evidence, both theoretical and experimental, that the photo-electric absorption of radiation is most intense when its quantum exceeds the minimum quantum necessary to eject the absorbing electron but does not exceed it too much. In the simplest theoretical case the absorption is zero for radiations the frequencies of which lie below the minimum quantum, rises to a maximum for a frequency comparable with the minimum, and falls off to zero again at infinite frequency. This case has not been realised in practice, but, broadly judged, the experimental data are in harmony with it. On these general grounds we should expect intense absorption by all kinds of matter for the radiation between the ultra-violet and the X-ray region.

The Botanic Gardens, Victoria, Cameroons Province, Nigeria.

HIS Excellency the Governor of Nigeria, Sir Hugh Clifford, G.C.M.G., in a remarkable address to the Nigerian Council,[1] which is deserving of careful study by those interested in our West African colonies, directed attention to the neglected condition of the Victoria Botanic Gardens in the recently acquired Cameroon Province, and stated that at his request the Assistant Director of the Royal Botanic Gardens, Kew, was about to visit Nigeria for the purpose of advising the Government "as to the action that should be taken for their restoration and future maintenance." We learn from the *Kew Bulletin*, No. 6, issued in September last, that Captain A. W. Hill has returned from his mission, and fully endorses the remarks made by the Governor as to the beauty and value of these gardens.

To quote from His Excellency's address:—

> The Botanical Gardens at Victoria compare in everything save size with their prototypes at Buitenzorg in Java and Peradeniya in Ceylon. They contain a fine and varied collection of trees and plants and shrubs which have been brought together from every part of the tropics; and, in spite of their close proximity to the sea, the soil in them appears to be abundantly fertile. A special feature of these gardens is a stream of water, crystal clear, that patters noisily over a bed of pebbles. . . .
>
> It would be a lasting discredit to this Government, I consider, if it were to neglect to repair the damage which the war has already unhappily inflicted upon these lovely and valuable gardens.

The gardens, we learn, cover an area of some 200 acres, and are provided with a good laboratory, a herbarium, and museum building, as well as a building which served the purpose of an agricultural school. All these are in a very fair state of repair, and are only awaiting the time when they can be restored to their proper functions. The site is admirably adapted to garden purposes, since the soil is a highly fertile decomposed volcanic rock. There are some steep hills, commanding fine views either across the bay or to the lofty Cameroon Mountain, but there is also a considerable tract of more or less level ground, so that it is possible to cultivate useful economic plants under varied tropical conditions. Connected with these gardens were the experimental plots of tea and cinchona at Buea, situated at an altitude of 3300–3600 ft., on the slope of the Cameroon Mountain. Photographs of these plantations are given in the Bulletin, and though now in a very neglected condition, they show that the cultivation of these products is a practical proposition in the Cameroon Province. High-level stations are thus a necessary adjunct to the gardens.

The importance of the Victoria Botanic Gardens and substations, with the laboratory and other buildings, where mycological, chemical and entomological research can be carried out, can best be realised when it is pointed out that the lower slopes of the Cameroon Mountain are covered by extensive plantations of such economic plants as cocoa, coffee, Hevea and Funtumia rubber, kola, bananas, oil palms, etc. The Cameroon Province thus differs essentially from Nigeria proper, where large plantations are rare and widely separated. In Nigeria fungus and insect diseases are not able to spread far, since

[1] Nigerian Council, Address by the Governor, Sir Hugh Clifford, December 29, 1920. See especially pp. 184–86 and 208–11.

there are dense tracts of forest or bush which act as a barrier; the native plantations also are usually small. In the Cameroon Province the plantations are more or less continuous, so that the risk of the spread of disease is ever present,

FIG. 1.—Ambas Bay, showing the seaward face of the Victoria Botanic Gardens which cover the promontory on which Government House can be seen crowning the summit. View looking to the south.—The trolley line from Victoria to Bota (the starting-point of the Buea Railway) is seen running at the foot of the cliff, which is the highest point of the gardens at the Bota end. The Limbe river, which traverses the gardens, enters the sea near the end of the promontory.

and the prosperity of the plantations depends very largely on the maintenance of an adequate scientific staff.

It is no doubt unfortunate for many reasons that the Cameroon Province, with the noble Cameroon Mountain, explored as long ago as December, 1861, by Sir Richard Burton and Mr. G. Mann, lies at one end of Nigeria, while Lagos and the headquarters of the Nigerian Agricultural Department at Ibadan lie far away near the Western border. Except by sea, communication between Ibadan and Victoria is at present well-nigh impossible, so that the proper development of the Victoria Gardens as a centre for research in connection with or under the control of the Agricultural Department of Nigeria, if this should be deemed essential, affords problems of considerable adminstrative difficulty.

While desiring to urge very strongly that the Victoria Gardens should be restored and maintained as a botanic garden fully equipped for tropical research in problems of soil chemistry, mycology, entomology, and plant-breeding, we would point out that research of this character belongs to a scientific institution, such as the gardens should be, rather than to an agricultural department, the function of which is purely technical and is concerned in the main with investigation and instruction.

The Victoria Gardens could be made the main centre for research in West Africa, and would be able to furnish results of immense value to the various agricultural departments; but we would urge that it should be established rather in connection with the Agricultural Department of Nigeria than under its direct control.

Reference has been made to the building which served as an agricultural school, and we would lay stress on the importance of such a school for the training of native agriculturists in a province like the Cameroons, with its large plantations. The value of such schools has been demonstrated in the West Indies and elsewhere, and with plantations demanding a large amount of skilled native labour a school attached to a scientific institute can scarcely fail to produce results of very great benefit.

The perusal of the narrative under review strengthens the conviction which we formed on reading His Excellency's address, that "it would be a lasting discredit" were we "to neglect to repair the damage" which the gardens have suffered and, we may add, were we to neglect the magnificent opportunity afforded us, with our great West African responsibilities, of maintaining them as a centre of scientific research in the tropics.

FIG. 2.—Pineapple plantation in the Victoria Botanic Gardens on the east side of the Limbe river.

Obituary.

DR. F. W. PASSMORE.

WE regret to announce the death of DR. FRANCIS WILLIAM PASSMORE at his home at Bexley Heath on Saturday, October 29. Dr. Passmore began his training with Dr. B. H. Paul. In those days London was probably the largest market in the world for cinchona bark, and Dr. Paul acquired no small reputation as a "quinologist." After five years in Dr. Paul's laboratory Passmore proceeded to Wurzburg, where he worked under Emil Fischer about the time the latter began his classical investigation of the sugars. He published three papers with Fischer on the formation of acrose from formaldehyde, the phenylhydrazides of acids derived from sugars, and on the synthesis of higher homologues of *d*-mannose.

On his return to London Passmore became an assistant at the Pharmaceutical Society's Research Laboratory, then recently started under Prof. W. R. Dunstan as director, with whom he contributed a paper to the Transactions of the Chemical Society on the formation and properties of aconine, the basic hydrolytic product of the highly toxic alkaloid aconitine. If one may judge from the four papers in which Passmore had collaborated up to this time, he would have made a valuable addition to the small band of workers who have devoted attention to the chemistry of natural products in this country.

The death of his father made it necessary for him to take up more lucrative work, and he joined the late Mr. H. Helbing as a consultant and analyst. His success as an expert witness led to his being constantly employed in patent cases involving chemical questions of all kinds, but he retained his interest in drugs, and from time to time published notes, arising out of his professional work, on such subjects as wool-fat, eucalyptus oils, salicylic acid, chloroform, coal-tar disinfectants, and potassium bromide. These notes were for the most part concerned with standards of purity and methods of analysis, and were written in collaboration with his partner.

Passmore was also interested in the manufacture of saccharin, and devoted some attention to processes for the production of synthetic camphor, but it is as a consultant that his frank and engaging personality will be chiefly missed.

DR. OSCAR MONTELIUS.

By the death of Dr. Oscar Montelius at Stockholm on November 4 the study of the prehistory of Europe has suffered a grievous loss.

Gustaf Oscar Augustin Montelius was born in Stockholm in 1843. He was attracted to the study of archæology at an early age. His first paper on the subject was published as long ago as 1869. An accomplished linguist—he seemed equally at home in most European languages—and the master of a ready pen, throughout a period of more than fifty years he was a constant contributor to the scientific journals both of his own and of other European countries, as well as the author of numerous books, several of which have been translated into English. Notwithstanding the volume of his published works, it is safe to say that not one word of his writings is not deserving of careful consideration. Of these his "Primitive Civilisation in Italy" is the most considerable, and probably will also be the most enduring. Montelius was well known personally in this country, and had contributed papers to *Archaeologia* and the Journal of the Royal Anthropological Institute, and in 1904, at the Cambridge meeting of the British Association, which he attended as a distinguished guest, he read a paper before Section H on "The Origin of the Lotus Ornament." His greatest and most lasting service to archæology lay, beyond question, in his investigation of the Bronze-age culture upon lines which enabled him to formulate a systematic scheme of chronology for that period.

Montelius was for many years a director of the State Museum of Sweden. He was a fellow of the Swedish Academy, and an honorary fellow of many European societies. In 1913 thirty-seven archæologists of European reputation, representing ten different countries, united to do him honour in a handsome memorial volume presented to him on his seventieth birthday.

WE regret to announce the death of Mr. E. WINDSOR RICHARDS, on Saturday, November 12, at ninety years of age. Mr. Richards started his career at the age of twenty-three as an assistant engineer with his brother at Tredegar Iron Works, thus beginning a connection with the iron and steel industry which he maintained throughout his life. While still a young man, he was appointed chief engineer at the Ebbw Vale Steel Works, where he designed and constructed a special blast furnace for the production from Somerset spathic ore of spiegeleisen, which until that time had been imported from Germany. In 1876 Mr. Richards became general manager, and later chairman and director, of Messrs. Bolckow, Vaughan and Co., of Middlesbrough, where, in co-operation with Thomas, the basic method of steel manufacture was successfully launched. In recognition of his services to the iron and steel industry, Mr. Richards was awarded in 1884 the Bessemer gold medal of the Iron and Steel Institute, of which ten years later he became president. He was also a past-president of the Institution of Mechanical Engineers and of the Cleveland Institution of Engineers.

THE death is announced of PROF. SHERIDAN DELÉPINE, professor of public health and bacterio-

logy in Manchester University, and director of the public health laboratories of the university, which occurred on November 13 last, at the age of sixty-six years.

We learn with regret of the death, which occurred recently, of Tadeusz Godlewski, professor of physics and formerly rector of the Technical High School, Lemberg (Lwów), Poland.

It is announced that Mr. John Macalister Dodds, fellow and formerly tutor of Peterhouse, Cambridge, died on November 13 at the age of sixty-three years.

We regret to announce the death on Sunday, November 13, at the age of eighty-one years, of Sir C. Douglas Fox, past-president of the Institution of Civil Engineers.

Notes.

H.M. the King has approved of the following awards this year by the president and council of the Royal Society: A Royal medal to Sir Frank Dyson, Astronomer Royal, for his researches on the distribution and movement of the stars; and a Royal medal to Dr. F. F. Blackman, for his researches on the gaseous exchange in plants and on the operation of limiting factors. The following awards have also been made by the president and council: The Copley medal to Sir Joseph Larmor, for his researches in mathematical physics; the Davy medal to Prof. Philippe A. Guye, for his researches in physical chemistry; and the Hughes medal to Prof. Niels Bohr, for his researches in theoretical physics.

The memorial tablet to the late Lord Rayleigh executed by Mr. Derwent Wood, R.A., is now complete, and is being placed in the position selected for it in the north transept of Westminster Abbey, between the memorials to Sir Humphrey Davy and Dr. Thomas Young. The Dean of Westminster has arranged for the unveiling ceremony to be held on Wednesday, November 30, the anniversary day of the Royal Society, at 2 p.m. Sir Joseph Thomson, as chairman of the memorial committee, will represent the University of Cambridge and the Royal Society.

The Stockholm correspondent of the *Morning Post* announces that the Nobel prize for chemistry for 1920 has been awarded to Prof. Walter Nernst, of Berlin University. The prizes for chemistry and physics for 1921 have been reserved for next year.

In a discussion in the House of Lords on November 10 the Marquess of Crewe voiced the complaint of teachers and students of science that the Safeguarding of Industries Act and the German Reparation (Recovery) Act had had the effect of hampering research and the teaching of science. The former act imposed high penalties on professors and education authorities generally who were forced to purchase materials abroad—materials which would never be produced in this country; the latter caused considerable delay in getting German books. It was a foolish policy, he urged, to discourage that research upon which the prosperity of the country so largely depended for the sake of the small amount of revenue extracted from underpaid professors and underfed students. Viscount Haldane suggested that a licence should be given by the Research Department or the Board of Education for getting the things required for research. The excellence of German scientific goods was due to the workman's spirit and tradition, and British research could not wait while British workmen were imbued with these attributes. In reply Viscount Peel stated that the Government were prepared neither to issue licences nor to grant import exemptions to educational institutions. It might be possible, however, to remove from the schedule articles which could not be produced in this country. He undertook to place the whole subject before the Minister of Education. In a leader in the *Times* of November 14 it is pertinently remarked, as evidence of the aloofness of the State from science, that "the interpellations on this scientific question were addressed to the Minister of Transport," who undertook to refer it, not to the Royal Society—"at one time the natural adviser of the Government on scientific matters"—but to the Minister of Education.

The annual council meeting of the National Union of Scientific Workers was held at the University of London Club on November 12. The retiring president, Prof. L. Bairstow, in his address, referred to the friendships formed with kindred organisations as an indication of the solid progress the union had made in its development as an element in the life of the scientific community. While the union's aims were in part economic with immediate objects, the consideration of effects to be produced by a higher idealism had claimed the greater share of attention. The Royal Commission on Awards to Inventors provided a striking example of the contrast in methods of treatment between the independent worker and the salaried worker. In the statement it presented to the Interdepartmental Committee on Patents the union had suggested that the latter method was the proper basis of treatment for all. The union should now make preparations for the collection of material ready for the next occasion on which revision of the patent law occurs. Prof. Bairstow quoted from the Press reports of the preliminary findings of the "Geddes" Committee on Economy, which indicate that the War Research Departments were threatened by the "axe." This was folly, for the greatest economies depend on research and education. Everything depended on the interpretation of the word "research"; much of the money allocated to research was actually expended on technical development. Most scientific workers regard the war period as a lean time for scientific research while agreeing that it was one of intense application of science. Prof. Bairstow concluded by expressing

the hope that scientific workers would seek for representation before Parliament by one of themselves. Dr. A. Griffith, of the Royal Aircraft Establishment, was elected president for the ensuing year, and Prof. J. Stanley Gardiner, of Cambridge, president of the research council.

THE Advisory Committee for the Meteorological Office, Edinburgh, met in Edinburgh on November 4, under the presidency of Dr. G. C. Simpson, Director of the Meteorological Office. This was the first meeting of the Committee since the completed organisation under the Air Ministry. The Committee is composed of representatives of the Fishery Board for Scotland, the Board of Agriculture, the Scottish Board of Health, the Scottish universities, the Royal Society of London, the Royal Society of Edinburgh, and the Royal Meteorological Society (with which the Scottish Meteorological Society is now amalgamated). Dr. Crichton Mitchell, the superintendent of the Edinburgh Meteorological Office, was also present. After paying a tribute to the memory of the late Dr. W. S. Bruce, the Director, in a brief historical statement, explained how the former relations between the Government and the Scottish Meteorological Society had gradually led to the establishment in Edinburgh of a Scottish branch of the Meteorological Office, by which the important voluntary work previously carried out by the society would henceforth be controlled. A description of the work now being developed was given, including an account of the observatories, telegraphic reporting stations, climatological stations, and rainfall stations. In the discussion which followed the applications of meteorology to fisheries, agriculture, and public health were considered, and various suggestions were made as to the possibility of closer and more fruitful co-operation between the Meteorological Office and these public bodies. Perhaps the most immediately practical point brought forward was the question of issuing a daily weather report in Edinburgh. A demonstration of this was carried out successfully during the recent meeting of the British Association.

MONTPELLIER, where the President of the French Republic, M. Millerand, has just unveiled a monument to the great satirist Rabelais, boasts one of the oldest universities. Its botanical gardens, in which the statue has been erected, is the oldest in France, and for more than two hundred years it has possessed an Academy of Sciences. On two occasions, in 1530 and in 1536, Rabelais was a student of medicine there, and to him was due the introduction into France of the melon, the artichoke, and the carnation. Though best known for his "Gargantua" and "Pantagruel," Rabelais, like his contemporary Paracelsus, was versed in all the learning of his day. The Montpellier Academy of Sciences was founded mainly through the efforts of the astronomers Plantade and de Clapies, and the inauguration took place on May 12, 1706, the day on which Plantade and de Clapies watched a total eclipse of the sun, the first eclipse of modern times of which the accounts are in any way full and precise. Plantade was a lawyer by profession, de Clapies a retired soldier and an engineer. Both were natives of Montpellier. De Clapies died in 1740, and the following year Plantade expired suddenly when making scientific observations on the Pic du Midi. Montpellier was also the home of Balard, who taught in the School of Pharmacy and, while botanising in the neighbouring salt marshes, studied the crystallisation of salts, which led him in 1826 to the discovery of bromine, for which our Royal Society awarded him a Royal medal. Soon after this Balard succeeded Thénard at Paris, and it was in his laboratory at the Ecole Normale that Pasteur, then his assistant, made his epoch-making discoveries in tartaric acid. Another eminent chemist connected with Montpellier was Gerhardt, who occupied the chair of chemistry from 1844 to 1848.

WE congratulate our contemporary, *The Electrician*, on the celebration of its diamond jubilee last week. During the past sixty years it has minutely recorded the growth of the numerous applications of electricity, and the record contained in its pages settles, both from the scientific and the technical point of view, many questions of priority. It is interesting to find that Faraday was one of its contributors. In 1862 he published a paper on "Electrical Illumination in Lighthouses." In 1861 telegraphy, the only practical application of electricity, was in private hands. The earliest telegraph was erected on the London and North-Western railway between Euston and Chalk Farm so far back as 1837 by Cooke and Wheatstone, but the lack of the means of making accurate measurements of the new quantities involved hampered progress. The important paper on "The Measurement of Electrical Quantities," published by Latimer Clarke and Sir Charles Bright in *The Electrician* for 1861 was a great step in advance. It is interesting to notice that these authors call the volt the "ohma," the ampere the "galvat," and the ohm the "volta." Fifty years ago submarine cables of more than 500 miles in length were worked in one direction only. The receiving instrument was a reflecting mirror galvanometer, the signals being read out by one operator and written down by another. The operators in those days were extremely skilful. From 125 to 150 letters per minute could be transmitted. For long distances the messages were sent in sections. For example, from Gibraltar to London the message had to be "man-handled" eight times. Nowadays automatic relays do the intermediate operations at far higher speeds, and a message can be sent automatically from London to Singapore.

MR. J. S. HIGHFIELD, in his presidential address to the Institution of Electrical Engineers on November 3, discussed the education of an engineer and various important financial problems concerning the future of the industry. He impressed on engineers the importance of giving their skilled assistants and their apprentices theoretical knowledge and opportunities for improving their manual skill. Manual skill can be acquired only from hand-skilled men. In his opinion there were no unskilled trades, but, unfortunately, there were many unskilled workmen. He considered that although trade unions had done good

work they had done harm by forcing the principle of standard wages and by reducing output. All progress in industry depends on the ability of the individual or firm to give part of his "profits" to new ventures. It is only when profits are adequate that facilities can be given for education and research. At the present moment profits are not being earned by the great trading community in this country. Consequently many are wanting work, and many are in distress. It is necessary that masters should instruct their men as to the conditions that will ensure their mutual well-being. Much is being done to secure a common understanding. This will doubtless lead to a co-operation between masters and men such as has not been known for years. We can then go forward with the certainty that prosperity will return.

THE next congress of the Royal Sanitary Institute will be held at Bournemouth on July 24–29, by invitation of the Mayor and Town Council.

THE *Revue Scientifique* for October 22 contains an account of the celebration of the centenaries of the great Alsatian chemists Gerhardt and Wurtz, which took place at Strasbourg on July 5 last. An account of the work of Gerhardt and Wurtz is given by Prof. Tiffeneau, of Paris.

THE issue of the Journal of the Society of Chemical Industry for October 31 contains a reasoned summary of the information which has appeared on the Oppau explosion. It is stated that many possible causes of the explosion were not taken into consideration in the report issued by the directors of the Badische company, and that an independent investigation by an expert Allied Commission is required.

THE ninety-sixth Christmas course of juvenile lectures, founded at the Royal Institution in 1826 by Michael Faraday, will be delivered this year by Prof. J. A. Fleming on "Electric Waves and Wireless Telephony." The lectures, which will be experimentally illustrated, will be given on the following days at 3 o'clock:—December 29, "Surface Waves on Liquids"; December 31, "Waves in Air"; January 3, "The Telephone"; January 5, "Electric Oscillations"; January 7, "Electric Waves"; and January 10, "Wireless Telephony."

IN addition to its ordinary programme, the Optical Society has arranged a series of special meetings to be devoted to subjects dealing with the evolution and development of various types of optical instruments. The Science Museum, Kensington, possesses a most interesting, and in many respects unique, collection of such instruments, with the characteristics of which instrument makers and users might well be more familiar. By arrangement with the museum authorities these instruments will be available at the meetings for purposes of illustration and demonstration. The first meeting of the series will be held at the Imperial College of Science and Technology on Thursday, November 24, at 7.30 p.m., when Prof. F. J. Cheshire will deal with "Polarising Apparatus." Other subjects to be discussed at future meetings include "Microscopes" (Prof. A. Pollard), "Telescopes" (Mr. D. Baxandall), and "Astronomical and Surveying Instruments" (Mr. L. C. Martin).

ALTHOUGH under the ban of the "Comstock Law," the scientific discussion of birth control is widely recognised in the United States as of great racial importance. Dr. Marie Stopes was invited by the Voluntary Parenthood League to New York to speak in the Town Hall on the subject on October 27. Following the lecture, which was enthusiastically received, a group of society leaders met the next day, subscribed sufficient funds, and organised a managing committee in order to open clinics immediately in America, following so far as possible the lines of the Constructive Birth Control Clinic founded by Dr. Marie Stopes and Mr. H. V. Roe in London this year. The position differs somewhat from that in England, for in the United States it is still legal to give clinical instruction only to persons already diseased. Those who are healthy and desire to remain healthy are not permitted this knowledge. It is, however, one step in racial advancement that the diseased should be shown how to avoid procreating their kind.

THE Ministry of Transport has issued an informal memorandum which summarises some experimental work (done at Alresford, in Hampshire) on the effect of drainage from tar-macadam roads on fish-life. Recently-tarred roads are certainly potentially dangerous. The first rain-washings must be mixed with at least an equal volume of clean water if they are not to be actively toxic to fish. Even when the dilution is several times that mentioned the effects may be prejudicial, and to be sure that no poisoning may occur the dilution must be ten to one at least. After the first washings are swept away the surface becomes less objectionable. There is evidence that storage of the drained-off water reduces its toxicity to fish-life, and it appears also that filtration through freshly cut turf may also diminish the danger. When the tar-macadam surface undergoes further severe disintegration it may again become dangerous. The experiments are still incomplete and are being continued, but the provisional results are helpful to conservators and others, and point to remedial measures in the case of valuable fisheries.

A COLD snap occurred in the weather over England during the second week of this month, and the first fall of snow for the present winter was experienced in London on the evening of November 11, whilst during the succeeding night at Greenwich the sheltered thermometer fell to 27° F., and it was 21° F. on the ground open to the sky. The mean temperature in London for the first six days of November was 49°, and for November 7–12 it was 15° colder. The ponds and ornamental waters around London were coated with ice. The first week of November is a fairly well recognised warm period in Great Britain, whilst the second week is one of Dr. Buchan's cold periods, associated with northerly winds. In 1910 November had sixteen frosty nights at Greenwich, and in the last eighty years there is only one other instance with so many, in the year 1851. In 1908 there was

a short, but severe, early cold snap in November, the sheltered thermometer at Greenwich on November 10 registering 22° F., and on the grass the reading was 9° F. The coldest November at Greenwich occurred in 1871, when the mean temperature for the month was 38°. In 1890 a severe frost set in over England on November 25, the thermometer registering 18° F. in the shade on November 28, the lowest shade temperature on record for the month, and the maximum temperature for the day was only 27° F.; the frost continued practically without interruption until the end of February.

ON June 30 of this year the Manchester Museum celebrated its hundredth birthday, and in the November issue of the *Museums Journal* its keeper, Dr. W. M. Tattersall, takes occasion to give a brief history of the museum.

MR. W. BELLOWS, Tuffley Lawn, Gloucester, sends us the following extract from a letter received on November 9 from a correspondent in southern Manitoba (30 miles from the United States frontier):—"Perhaps you remember the little creek or river which runs through part of my land. A colony of beavers has built a house and dam, and, I fear, will flood my hay-land. I must apply to the Government for permission to break the dam. These creatures are increasing rapidly and will do much damage. They have now cut down a number of my trees of good size, and, if unmolested, will destroy all near. They are strictly protected; permission has to be obtained before one may be killed."

A DETAILED study of the races of Japanese domestic cattle, based on the examination of a large series of skulls, as well as on observations of the external morphology, forms the subject of a paper by Mr. Kenzo Iguchi in the Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan (vol. 9, part 5). The author concludes that the domestic cattle of Japan are not native, but have been derived from the races of cattle of North China brought over by way of Chosen on the wave of migration which carried the ancient culture of China to Japan. Discussing the origin of Chinese cattle, Mr. Iguchi supports the view that they have been derived by an uninterrupted course of domestication from the zebu of northern India, which he regards as the ancestral wild parent of all the races of eastern Asiatic cattle.

THE conservation of the wild or native fauna of any part of the world will depend primarily upon economic considerations. The ideal of preventing, for scientific reasons, the extinction of wild species, because they *are* wild and represent the native fauna, will never be reached or even considered when commercial interests are at stake. It is from this aspect first and last that the problem is viewed. This is well instanced by the publication of two articles in the Yearbook of the United States Department of Agriculture, 1920, with the contradictory titles, "Conserving our Wild Animals and Birds," and "Hunting down Stock Killers." This apparent paradox is explained by the fact that the first article advocates increased measures for the protection of those animals and birds which are of commercial value, and the second details the work that has been done in the systematic destruction of the native Carnivores which take such enormous toll annually from the stock-farms and ranches of North America. The man of science and field naturalist will learn with satisfaction of the good results already discernible from the Migratory-bird Treaty Act of 1920. He can have nothing but admiration for the splendid work which the American Government has done in the preservation of bison, elk, antelope, and deer, and will welcome any measures which will save from extinction the small fur-bearing mammals of the Northern Territories. On the other hand, he will reflect that the Carnivores are at least a virile and dominant family which the most rigorous hunting may keep in check but hardly exterminate.

THE Hugo Müller lecture delivered before the Chemical Society on June 16 last by Prof. Benjamin Moore is printed in the October issue of the Journal. Prof. Moore spoke on "Photosynthetic Processes in the Air, upon the Land, and in the Sea in Relation to the Origin and Continuance of Life on the Earth." In dealing with this wide subject an attempt was made to trace the continuity of life from the inorganic world to the highest types of organism. Radiant energy from the sun is responsible for building up simple inorganic and organic compounds, including nitrogen compounds, from the air; the nitrogen of the atmosphere may be converted into proteins. Photosynthesis occurs not merely in the region of the absorption bands of chlorophyll, but throughout the spectrum, and the chlorophyll may be a colour-screen protecting the organism from the blue and ultra-violet rays, which are prejudicial to life. Prof. Moore describes many experiments in support of his novel and interesting views.

THE description of a new dye-printing photographic process is contributed by Dr. J. M. Eder to the *British Journal of Photography* for November 4. This method is distinct from Willis's aniline process (1864), Feer's diazotype (1889), Andresen's diazotype (1895), and the primuline process of Green, Cross, and Bevan (1890). It has been patented by the Badische Anilin- und Soda-fabrik. Benzidine hydrochloride or other diamine compound is precipitated with an acid dye such as eosine, cyananthrol, Neptune-green, or quinoline-yellow, according to whether the print is to be a bright purplish-red, a dark violet, a bright green, or brown. The precipitate is mixed with manganese nitrate or a similar oxidiser and water, and coated upon paper. After exposure under a negative, fixing is done in a solution of borax or of sodium phosphate. So far pure whites have not been obtained, but the great brilliancy and variety of colour that are possible, and the good gradation and vigour of the prints, render the process, in Dr. Eder's opinion, worthy of attention.

SOME engineering uses of stainless steel, which is an alloy steel containing from 12 to 14 per cent. of chromium, are described in an illustrated article in

Engineering for October 28. The principal experiments described had for their object the determination of the suitability of the material for steam-turbine blades. In 1916 the British Thomson Co., of Rugby, fitted in one of their turbines an experimental wheel having blades of phosphor-bronze, nickel-bronze, brass, mild steel, and stainless steel. Of the four stainless steel blades inserted two were hardened and the other two were hardened and tempered. This turbine was at work from the autumn of 1916 until April, 1918, when it was opened out for the first time. All the blading was in good condition, but the stainless blades were the only ones entirely free from erosion or corrosion. The machine was put to work again and re-examined last July, when it was found that the stainless steel blades appeared to be absolutely unaffected by their service; further, the hardened and tempered blades were in as perfect condition as the hardened blades. All the other materials had suffered, some severely. Messrs. Firth and Sons fitted stainless blades 28 in. long into a turbine four or five years ago, and report that these also have given entire satisfaction. Other confirmatory experiments are described in the article. The subject is of very great importance in turbine manufacture, and it would appear from the tests that in turbine blading erosion and corrosion trouble can now be entirely eliminated.

THE new catalogue (No. 364) of important and rare books on natural history, issued by Messrs. B. Quaritch, of 11, Grafton Street, W.1, contains nearly 800 titles. Interesting items we have noticed are two volumes of the "Index Kewensis" (1885–95), an edition, published in 1836–39, of Cuvier's "Basis of the Natural History of Animals," a Settin edition of Gilbert's "De Magnete," a copy of the first edition of Darwin's "Origin of Species," and the extensive collection of English and foreign pamphlets on Diatomaceæ, from the library of the late Wynne E. Baxter.

MESSRS. LONGMANS AND CO. have in the press a new book by Prof. A. W. Stewart entitled "Some Physico-Chemical Themes," which is intended to form a connecting link between systematic text-books of physical chemistry and the original literature of the subject. Among the subjects treated of will be double and complex salts, pseudo-acids and indicators, non-aqueous ionising media, colloids, the Brownian movement, absorption, catalysis, chemical affinity, emission spectra, the determination of Avogadro's constant, the periodic law, and atomic structure.

Our Astronomical Column.

BRIGHT ASSEMBLAGE OF MORNING STARS.—Mr. W. F. Denning writes: "During the remainder of the present month there will be visible before sunrise all the brightest planets, viz., Mercury, Venus, Mars, Jupiter, and Saturn, and in addition to these objects the crescent of the Moon will be visible in the south-eastern sky from about November 25–28.

"It is only at long intervals that so large a number of interesting planets occupy positions in the heavens enabling them to be viewed at the same time. Towards the end of the month Mars, Jupiter, and Saturn will be near one another, and they will be in conjunction with the Moon on November 25. Mercury and Venus will also be near together and low in the south-eastern sky, and on November 28 they may be seen near the narrow crescent of the moon. The best time at which to view these objects will be from about 6.30 to 7 a.m. Of the planets named Venus will appear to be much the brightest, while Jupiter will rank second."

MEDIEVAL ASTRONOMICAL INSTRUMENTS IN INDIA.—Memoirs of the Archæological Survey of India (No. 12) contains a description by G. R. Kaye of some medieval instruments of beautiful workmanship now in the Delhi Museum. There are three astrolabes belonging respectively to the thirteenth, fifteenth, and seventeenth centuries. They contain planispheres on which the principal stars are delineated with such accuracy that the date of construction can be ascertained within a few years by simple measurement of longitude. The stars' names are recorded in Arabic, and a glossary of their meanings is given in the memoir. It may be noted that the name Achernar (the last of the river) is applied to the third magnitude star θ Eridani, not to the bright star, 17° further south, that now bears it.

There are also tablets on the astrolabes giving the latitudes of several towns, and other details such as the length of the longest day.

The celestial sphere is of brass 6·5 cm. in diameter; it bears the date A.H. 1087 (or A.D. 1676). In spite of the small scale, the stars' positions are so accurate that their measured longitudes led to the date 1664.

It is of interest to note that the Arabs borrowed at least three constellation names—Thaur, Qantaurus, and Qitus—from the Greek, and that they call Betelgeux and Bellatrix the right and left shoulder of Orion; in other words, they take the figure as shown on a star-map, not on a globe, as some medieval European astrologers used to do.

NOVA AQUILÆ.—It is praiseworthy that of late years a number of observers have studied novæ on their decline, long after they have ceased to be spectacular. Comparison of their ultimate with their original condition is of value as likely to afford information as to the character of the event that produced the sudden outburst. Nova Aquilæ is a particularly favourable star to take for this purpose, as a long series of photographs of the star in its pre-nova state is available. It was then of about the 10th magnitude, but seemed to be irregularly visible to the extent of half a magnitude.

Popular Astronomy for October contains, in its Variable Star Report, numerous observations of the star made last summer. Each of the following values is the mean of about eight observations:—

1921, June 8, 9·44 mag.; July 1, 9·47 mag.; July 13, 9·64 mag.; July 28, 9·60 mag.; August 6, 9·47 mag. The observations leave it an open question whether there are short-period fluctuations; if such exist, their amplitude can scarcely exceed 0·2 mag. It will be seen that the star, in three years from the outburst, has declined to within some half-magnitude of its original brightness.

British Scientific Instrument Research Association.

THE British Scientific Instrument Research Association has recently issued its third annual report, which gives a very brief account of the further development of the organisation of the association and of the researches in progress. The membership comprises some twenty-five or more of the principal instrument-making firms of the country; the director, Sir Herbert Jackson, is assisted by a scientific staff of seven members, in addition to the secretary. The present chairman of the association is Mr. Campbell Swinton.

Three years are a short time in the life of a research institution. Much of the time has, no doubt, been spent in the preliminary planning of the programme of research, in securing staff, and in providing and installing what must still be a somewhat modest equipment. It is to the credit of the staff that they have already succeeded in producing results, along more than one line of investigation, of definite value to the members of the association, and, no doubt, ultimately to the users of scientific apparatus and to science generally. The lines of work which have been mainly followed are clearly indicated by the report, though, since the knowledge acquired by a research association remains, for a time at least, confidential to its members, the details given of the results achieved are somewhat limited.

Experiments have been made in the production, on a small scale, of optical glasses of new types, directed more particularly to the provision of a substitute for alum in apochromatic lenses and some other special requirements in optical design. Information has been obtained with regard to neutral-tinted glasses of uniform spectral absorption and coloured glasses for photographic purposes, which it is hoped may lead to production on the manufacturing scale. The durability of optical glasses has been the subject of special study, and research on the viscosity of glass has been promoted, and has led to a new method of determining viscosity applicable to glass at high temperatures.

Much attention has been devoted to abrasives and polishing powders. In this work considerable success has been attained, and results of theoretical interest, as well as of practical value, have been secured. It is understood that a general account of these will be published. Cements for prisms and lenses have been investigated and some improvements are recorded. Other materials to which attention has been given are a wax mixture for use as a temporary adhesive and solders of high and of low melting point. The progress made should be of definite value to optical instrument-makers as well as in other allied industries.

The other main section of the work relates to electrical and X-ray apparatus. Probably the most notable success so far achieved by the research staff of this section has been the production of a convenient regulator of new type for X-ray tubes, which enables the tube to be "hardened" or "softened" as desired, thus considerably extending the life and usefulness of the tube. An investigation is in progress which it is hoped will lead to manufacturing improvements in the focussing of X-ray tubes. The wave-form for use in the generation of X-rays is also being studied. Other investigations which have been undertaken relate to the magnetic properties of materials used in galvanometer coils and to insulators and insulating varnishes and enamels.

Many of the research associations so far formed have few facilities for carrying out research under their own immediate control, and, in common with others, the British Scientific Instrument Research Association has devoted some portion of its funds to the promotion of investigations by other institutions and individual workers into problems of importance to its members. The National Physical Laboratory is collaborating with the association in an investigation relating to radio-luminous paint. Work of great importance to the electrical instrument-maker has been done at the laboratory in the production of a resistance material of small temperature coefficient similar to "manganin," samples of which are being supplied to the association for trial by its members under manufacturing conditions. Researches undertaken by individual investigators include the examination of liquids suitable for level bubbles, the work already mentioned on the viscosity of glass, the study of magnet steels, and questions arising out of an investigation of tissue-paper as a wrapper for polished glass surfaces. The design and construction of an integrating nephelometer may also be mentioned.

The aim of a research association must be to improve British industry and enable it to compete more successfully in both home and foreign markets by the utilisation of the most advanced scientific knowledge and methods. This implies the cordial co-operation of its members for the common good, and the extent to which this principle is brought into operation affords some measure of the advantage which the members are likely to derive from their association. The principle appears to have been adopted more fully by the British Scientific Instrument Research Association than by some others, and this is of good augury for its future success. The list of subordinate investigations with which the report concludes, due to individual inquiries, indicates how valuable the assistance of such an association may be to its component members if the director and his staff are allowed reasonable freedom in the use of their knowledge and experience to remove the difficulties met with by individual members in the course of their work and in giving advice for the improvement of their products. Investigations carried out for one of the associated firms are paid for by the firm, and thus add to the revenue of the association. The help which can be given in this manner will increase steadily in importance as the staff gains experience in dealing with the technical problems of the instrument-maker.

Arctic Medusæ.

WE have received copies of parts of the Report of the Canadian Arctic Expedition, 1913–18; the Medusæ and Ctenophora are dealt with by Dr. H. B. Bigelow, the Polychæta by Dr. R. V. Chamberlin, and, in the portion devoted to the Crustacea, the Cumacea by Dr. W. T. Calman, the Isopoda by Mr. P. L. Boone, the Amphipoda by Mr. C. R. Shoemaker, and the parasitic Copepoda by Dr. C. B. Wilson. The collection of Medusæ, which is only the second which has been made on the Arctic coast of America, comprises species well known either from some part of the North Atlantic or from its Arctic tributaries. One species only is new. Dr. Bigelow refers to the importance, especially to the oceanographer, of estab-

lishing definitely which of the Arctic Medusæ are certainly produced in those seas; for such floating buoys are sometimes of great assistance in indicating the origin, northern or southern, of the constituent waters of ocean currents. The Medusæ have the advantage, as compared with Arctic diatoms, of larger size and easy identification. Dr. Bigelow points out that there is at least one Anthomedusa, *Sarsia princeps*, which has now been recorded from so many parts of the Arctic and from currents flowing from it (*e.g.* the Labrador current), but from nowhere else, that it can safely be taken as an indicator of Arctic water. The report on the Isopoda has been extended to include other material from the Arctic, and forms a summary of our present knowledge of the Isopoda of that region. The Amphipoda reported are, for the most part, well-known Arctic species, but one—a species of Synurella—is new, and this genus is recorded for the first time in American waters. *Katius obesus*, known previously only from the Atlantic, is now reported for the first time from the Pacific. Appended to the report on parasitic Copepoda is a useful list of the species which have been recorded from the Arctic up to the present.

University and Educational Intelligence

BIRMINGHAM.—The Huxley lecture is to be delivered on November 25 by Prof. C. Lloyd Morgan, who has chosen as his subject "A Philosophy of Evolution."

CAMBRIDGE.—A congratulatory address to Dr. G. D. Liveing, for forty-seven years professor of chemistry in the University, was read by the Public Orator at the Congregation on November 5. The address was presented by the Vice-Chancellor to Dr. Liveing at St. John's College on Sunday, November 13.

Dr. J. Chadwick has been elected to a fellowship at Gonville and Caius College.

MANCHESTER.—The University has received from Messrs. Lewis's, Ltd., an offer of 1000*l.* a year for three years. A portion of this sum is to be utilised in providing scholarships each of the value of 200*l.* for one year, to encourage further study on the part of graduates who propose to enter industry and commerce. Under the proposed scheme one scholarship would be offered annually in each of the subjects, economics, commerce, and applied psychology. It is proposed that these scholarships should be open to graduates of any approved university, and that they should be awarded by the University. They will be known as the "Lewis's Scholarships in Commerce." The council has accepted the offer with gratitude. Detailed proposals for the scheme are at present under consideration, and will be announced in due course.

Mr. R. W. Palmer, of the Geological Survey of India, has been appointed senior lecturer in geology.

Mr. Stanley Wyatt, investigator to the Industrial Fatigue Research Board, has been appointed special lecturer in psychology.

MR. J. W. SCHARFF has been appointed lecturer in biology at King Edward VII. Medical School, Singapore.

THE *Times* announces that Sir Philip Magnus, member of Parliament for London University for the last sixteen years, has written to Sir Forrest Fulton, president of the London University Unionist Association, stating that, as he has entered his eightieth year, he has decided not to offer himself for re-election at the close of the present Parliament.

IT is announced that five or more commercial research fellowships of the approximate value of 500*l.* each are to be instituted by the executive council of the British Empire Exhibition, 1923. The fellowships will be identified with those towns the chambers of commerce of which obtain the highest aggregate of guarantees for the exhibition in proportion to their membership, and these bodies will also have the right of selecting the recipients. Each fellowship includes a first-class return ticket to the Dominion or Dependency to be visited, and research will be carried out under the following headings:—(1) The best means of promoting inter-Imperial trade in a selected staple industry; (2) the methods by which the forthcoming exhibition can promote this trade; (3) the potential resources in raw material of the country visited and the best means for their exploitation in the mutual interest of the producing country and Great Britain; and (4) the means whereby undeveloped resources may be adequately represented at the forthcoming exhibition and brought to the notice of the industrial and financial groups concerned. The subject for investigation will be determined by the local chamber through which the fellowship is awarded, and the fellows selected must proceed to their destinations before the end of March next. The closing date for entries for the competition is December 15, and the results will be announced on December 24.

BULLETIN No. 42, 1920, of the United States Department of the Interior, Bureau of Education, provides evidence that American colleges are suffering in the matter of staffing in much the same way as British universities and colleges, and for the same reasons. The bulletin contains reports of conferences on education for highway engineering and highway transport. The American colleges are very desirous of helping in the solution of highway problems, but they are limited in many ways, and especially in the matter of money. A large number of college faculty members are leaving because manufacturers offer higher salaries than the colleges can pay. "Under war conditions the teaching staffs were badly disorganised. Last year there was a tremendous influx of new students, and the appropriations have, in general, been far less than the enlarged needs. Salary budgets have not been revised to meet the competition of industrial engineering organisations, with the consequent loss of very many of the best qualified professors and instructors." There is a great deal more to the same effect, and the committee recommends that more ample funds must be provided from private sources, from co-operative efforts with industries, and from taxation.

WE have received two papers on "International Language in English and Ido," by Prof. Otto Jespersen, and a pamphlet on "The Auxiliary Language Ido," by M. L. de Beaufront. These papers trace the origin of Ido as a development from Esperanto, and claim that it is free from many defects to be found in the earlier artificial language. In 1907 an International Committee met in Paris to decide which artificial language was the most suitable to be introduced for international communications. After much discussion the Committee decided in principle to adopt Esperanto, but with the reservation that several changes should be made by a Permanent Commission. The changes made by this Commission were, however, not accepted by the supporters of Esperanto, so that the auxiliary language finally adopted by the Commission, instead of taking the place of Esperanto, appeared as a rival language under the name of Ido. The recent report of the Committee on an International Auxiliary Language made to the meeting of the British Association at Edinburgh recommends an invented language, and adds that Esperanto and Ido

are suitable. We would suggest to the Esperantists and Idists that, instead of accentuating their differences, they should endeavour to come to an agreement upon points of difference, and thus present a united front in their campaign in favour of an artificial language.

A FURTHER communication has reached us from Mr. Cyril Crossland (see NATURE, August 4, p. 733), who expresses the view that the use of Hebrew at the Jewish University in Jerusalem is an act of exclusiveness against non-Jews. He urges that Hebrew is a dead language, and only the Zionists are working for its revival, for purely racial and political ends. As a matter of fact, Hebrew is the real living language of the Jews in Palestine. It is the language of instruction of the Jewish schools in Palestine, both elementary and secondary, and is one of the official languages of the country. It would surely be an anomaly to have a Jewish university in Palestine without Hebrew as the language of instruction. Hebrew has already been used for scientific work with great success. To urge that the use of Hebrew means excluding non-Jews is the same as urging that the use of English at a British university means excluding Frenchmen or Germans. Mr. Crossland objects to the statement that Jews are opposed to clericalism, and asks, "Then how is it they remain Jews?" We suggest that he misunderstands the meaning of the word "clericalism," which signifies the usurpation of political power by the clergy, and to this Jews are opposed everywhere. Mr. Crossland refers to the college at Beirut, where instruction is given in English, and to the fact that there are in Palestine native qualified, energetic, and patriotic medical men who can deal with the public health of the country. These facts are irrelevant. Beirut is not in Palestine. Further, public health has been grossly neglected in Palestine, and to object to this being cared for by Jews is an inadmissible attitude.

SOME of the most striking developments of recent years in the education of the medical practitioner have been concerned with the increasing realisation of the need for placing the curriculum upon a solid foundation of pure science. This has in turn reacted upon the teachers of pure science, for it has stimulated their interest in the medical student, with the result that in various universities courses in pure science have been organised with a special eye to his needs. Such a course is illustrated by a pamphlet which has reached us from the University of Melbourne, dealing with the course in elementary physics for medical students in that university. The pamphlet, which is written by Mr. E. O. Hercus, lecturer in natural philosophy, in collaboration with Prof. Laby, is entitled, "Notes on Colloidal State, the Measurement of Blood-pressure, Conservation of Energy in the Human Body." The pamphlet is not a complete syllabus—probably the authorities of Melbourne University have learned what many of our authorities at home have failed to learn—that there is no surer way to deprive university teaching of all life than by forcing it to conform to a cast-iron framework in the shape of a rigid syllabus—but it serves at least to show that the Melbourne course is both interesting and useful. The dispersed condition of matter, solutions, colloids, the processes of filtration and dialysis, the scattering of light, Brownian movement, cataphoresis, coagulation and precipitation, the measurement of blood-pressure, and the energy-changes in the animal body—these subjects are all dealt with in the Melbourne course, and every one of them is of the most immediate importance to the student of the animal body and its functions.

Calendar of Scientific Pioneers.

November 18, 1854. Edward Forbes died.—Though only thirty-nine when he died, Forbes was regarded as the leading British naturalist of the first half of the nineteenth century. He wrote important geological, botanical, and palæontological papers, and furthered the study of marine zoology. Naturalist to the *Beacon* Expedition of 1841, he became professor of botany at King's College, London, and just before his death professor of natural history at Edinburgh.

November 18, 1887. Gustav Theodor Fechner died.—After resigning the chair of physics at Leipzig, Fechner turned to the study of psychology, which he endeavoured to make susceptible to mathematical treatment. He is remembered for the useful Fechner's law.

November 19, 1910. Rudolph Fittig died.—Professor of chemistry at Tübingen, where Ramsay was one of his students, and then at Strassburg, Fittig did original work on the benzene series and made an exhaustive study of unsaturated acids and lactones.

November 20, 1751. George Graham died.—The maker of Halley's mural quadrant and Bradley's sector, "honest George Graham" was the first mechanician of his age, and to him we owe the mercurial pendulum and the dead-beat escapement. He is buried with his master, Tompion, in the nave of Westminster Abbey.

November 21, 1815. James Archibald Hamilton died.—A pioneer among Irish astronomers, Hamilton in 1790 became the first astronomer of Armagh Observatory, founded by Richard Robinson, first Baron Rokeby.

November 22, 1881. Ami Boué died.—Of French descent, but born in Hamburg, Boué studied at Edinburgh, and in 1820 published the first general account of the geology of Scotland. He played a leading part in the formation of the French Geological Society in 1830, and afterwards settled in Vienna, communicating to the Academy of Sciences there important papers on the geology of the Balkan States.

November 22, 1907. Asaph Hall died.—A contributor to many branches of astronomy, Hall achieved popular fame by his discovery on August 11 and 17, 1877, of Deimos and Phobos, the outer and inner satellites of Mars. From 1862 to 1891 he was connected with the Naval Observatory at Washington, and afterwards held a chair of astronomy at Harvard.

November 23, 1826. Johann Elert Bode died.—The founder in 1774 of the *Astronomische Jahrbuch*, fifty-one volumes of which he edited, and known for his enunciation of Bode's law, Bode was a Hamburg schoolmaster who was called to Berlin by Frederick the Great and made a member of the Academy of Sciences.

November 23, 1844. Thomas Henderson died.—The first Royal Astronomer for Scotland, Henderson previously was director of the Cape Observatory. His publication of the determination of the parallax of α Centauri was made only two months later than the publication by Bessel of the parallax of 61 Cygni. These were the first determinations of their kind.

November 23, 1864. Friedrich Georg Wilhelm Struve died.—The fourth son of a Danish professor of mathematics, Struve in 1820 became director of the Dorpat Observatory, whence he removed to Pulkowa as the chief of the famous observatory erected by Tsar Nicolas I. and opened in 1839. Under Struve, Pulkowa became not only a great centre of astronomical work, but the centre also of important geodetical operations. E. C. S.

Societies and Academies.

LONDON.

The Royal Society, November 10.—Prof. C. S. Sherrington, president, in the chair.—A. J. **Wilmott**: Experimental researches on vegetable assimilation and respiration. XIV.—Assimilation by submerged water plants in dilute solutions of bicarbonates and of acids: an improved bubble-counting technique. The increase of "bubble rate" of carbon dioxide liberated from the cut stem of a water-plant when free acid is added to the water covering the stem is due to the effect of the acid upon carbonates present. No increase is found when soft water is used. In "bubble rate" experiments, solutions of carbonic acid and of sodium bicarbonate of known strength behave similarly.—E. G. **Young**: The coagulation of protein by sunlight.—E. G. **Young**: The optical rotatory power of crystalline ovalbumin and serum albumin.—A. R. **Ling** and D. R. **Nanji**: The longevity of certain species of yeast. Yeast cultures prepared in 1887 by the late Prof. Hansen were found to be still living. The form in which they have retained their vitality is not determined. *A. apiculatus* hibernates in the soil; since the yeast with which Hansen worked does not form endospores it may have been preserved as resting cells.—F. **Kidd**, C. **West**, and G. E. **Briggs**: A quantitative analysis of the growth of *Helianthus annuus*. Part I.—The respiration of the plant and of its parts throughout the life-cycle. The respiration of the plant was investigated (1) for calculating loss in dry-weight, due to respiration under field conditions, and, with the increase in dry-weight due chiefly to assimilation, to construct a "balance sheet" for the plant; (2) to determine effect of age of the plant (internal factor) upon its respiration, which was measured under standard conditions at weekly intervals throughout the life cycle. The amount of carbon dioxide (mgs.) per gm. dry-weight per hour produced by the respiring tissue under standard conditions is called the "respiratory index," which is a close measure of the "effective amount of respiring cell-matter." The relation between respiration and temperature (0–25° C.) was also determined. The "respiratory index" of the whole plant and of individual organs decreases throughout the life-cycle, in the case of the whole plant from 3 to about 0·3. Its fall follows closely the fall in "relative growth rate."—G. S. **Currey**: The colouring matter of red roses.

Royal Microscopical Society, October 19.—Prof. John Eyre in the chair.—Dr. L. T. **Hogben**: Preliminary account of the spermatogenesis of Sphenodon. The material of this research was preserved by Prof. Dendy. Examination of sections of testes of Sphenodon show:—(*a*) The diploid complex is markedly heteromorphic. (*b*) Synapsis is effected by parallel conjugation. (*c*) There is apparently no unpaired chromosome. (*d*) The probable number of diploid chromosomes is twenty-six. (*e*) Reptilian gametogenesis is at present an unexplored field that invites attention for the study of heteromorphic chromosome groups.

Physical Society, October 28.—Sir W. H. Bragg, president, in the chair.—S. **Butterworth**: The use of Anderson's bridge for the measurement of the variations of the capacity and effective resistance of a condenser with frequency. From an analysis of the effect of residuals and earth capacities in Anderson's inductance-capacity bridge, it is shown that if balances are obtained by balancing the bridge with *direct* currents, and making the alternating current adjustments by means of a small series resistance (s') and parallel condenser (C') in the condenser arm, then the changes required in s' and C' to hold the balance at different frequencies are equal and opposite to the variations of the effective (series) resistance and capacity of the condenser with frequency. The assumptions made are that the residual inductances and resistances of the "non-inductive" arms of the bridge are invariable with frequency, and that the resistance of the inductive arm varies as the square of the frequency. S. **Butterworth**: Notes on earth capacity effects in alternating-current bridges. An earth capacity acting at any point in the arm of a bridge may be replaced by two earth-impedances acting at the ends of the arm together with an impedance in series with the arm. By integration the result is extended to small distributed capacities. Two methods are given for the elimination of the error due to the end impedances. Complete elimination can be obtained only by the use of shields connected to the ends of the bridge arm.—F. G. H. **Lewis**: An automatic voltage regulator. Automatic voltage regulation to 0·15 per cent. may be obtained for the operation of a photometric standard lamp on an ordinary supply varying by 10 per cent. by placing the lamp across an unbalanced Wheatstone bridge, of which two opposite arms are composed of tungsten filament lamps. The increase of resistance of these lamps, when the outside voltage rises, causes a shift in the balance such that the voltage across the photometer lamp remains unaltered if the resistances in the arms be properly proportioned. The power taken is about forty times that used in the regulated circuit.—A. S. **Hemmy**: The flow of viscous liquids through slightly conical tubes. A formula is obtained by neglecting terms containing the square of the obliquity. Good agreement with viscosity found experimentally with tubes of differing degrees of conicality is observed.

Mineralogical Society, November 1.—Dr. A. Hutchinson in the chair.—Prof. H. **Hilton**: The determination of the optic axes of a crystal from extinction-angles. The problem of obtaining the positions of the optic axes of a crystal from the extinction-directions on four known faces was discussed, and it was shown from a purely geometrical point of view that the solution is unique. Their position was also found graphically as the intersection in the gnomonic projection of two cubic curves, on which any number of points can be obtained by the use of the ruler only.—W. Campbell **Smith**: Some minerals from Leadhills. Caledonite of pale blue colour and acicular habit has been frequently described in the past as aurichalcite. Examination of all available specimens of so-called aurichalcite from this locality showed that all were caledonite of this acicular habit. The optical properties were found to agree with those of caledonite of the normal habit. It was shown that in caledonite the plane of the optic axes is parallel to (010) and the acute bisectrix is perpendicular to (100), and not as stated in Dana and other text-books. Other remarks referred to gold, linarite, minium, and the rare mineral eosite.—Dr. J. **Drugman**: An example of porphyry-quartz from the Esterel Mountains (France) twinned on the face (10$\bar{1}$2). This twin-law in quartz has previously been observed only by Q. Sella in 1858, and has been regarded as doubtful. An example of it has been found amongst the porphyritic crystals in the "blue porphyry" of the Esterel Mountains. A distinction is made between the twins of low-temperature rhombohedral α-quartz and those of hexagonal β-quartz (stable at a temperature above 575° C.).—Dr. L. J. **Spencer**: Biographical

notices of mineralogists recently deceased, with an index of those previously published in the *Mineralogical Magazine*.

PARIS.

Academy of Sciences, November 2.—M. Georges Lemoine in the chair.—A. **Blondel**: Conditions of starting and of resonance of an alternator feeding a long high-tension line, with or without receiver.—M. **Riquier**: The complete families of integral figures of a system of partial differential equations of the first order, and the application of their properties to the theory of any differential systems.—J. Andrade was elected correspondant for the section of mechanics in succession to the late M. Vallier.—C. E. **Brazier**: The variation of the velocity of ascent of pilot-balloons with altitude. Theoretically, neglecting hydrogen losses and assuming that india-rubber preserves its elasticity, the velocity of ascent should increase regularly with the altitude; actually, the velocity is a maximum near the ground, decreases up to a height between 500 and 1500 metres, and then increases slowly up to 8 or 9 km. Various possible explanations of these facts are discussed.—P. and M. **Richard**: The general problem of aviation. The system of equations utilised by engineers in the design of aeroplanes is simply the analytical expression of the laws of similitude of aerodynamics. Experience in construction has hitherto been the only guide in fresh development. The authors give three equations, partly based on experience and partly on the laws of similitude, which may be used in place of those in current use. Some applications of these equations are indicated.—M. **Gevrey**: Linear partial differential equations admitting a single family of imaginary characteristics.—B. **Gambier**: Conformable correspondence between two surfaces, with conservation of the lines of curvature and of the absolute value of the ratio of the principal radii of curvature.—K. **Ogura**: The extension of a theorem of Liouville to the field of gravitation.—M. **Mercier**: The measurement of the velocity of propagation of electric waves along metallic wires. When a system of electrical oscillations is propagated along two parallel wires, they give rise to a system of nodes and loops. The velocity is known if simultaneous measurements are made of the wavelength and the period of the oscillations. The distance between the nodes can be determined with an accuracy of the order of one in a hundred thousand. The frequencies were measured on absolute value by the method of Abraham and Bloch. The velocities can be determined with an accuracy exceeding 1 in 10,000.—P. **Dejean**: The demagnetising field and paramagnetism.—C. **Raveau**: Is there a resolution of common salt in presence of a non-congruent solution submitted to evaporation?—M. and Mme. A. **Lassieur**: The rapid electro-analysis of brass. The copper is deposited in a sulphuric-nitric acid solution. A minimum amount of nitric acid is employed, and this is reduced to ammonia by electrolysis previous to the determination of the zinc.—J. **Martinet** and A. **Haehl**: The *m-m'*-dinitrodiphenylsulphone.—P. **de Sousa**: Some remarkable rocks from Angola. Nine complete analyses of these rocks are given and compared with two earlier analyses of rocks from the same district published by A. Holmes.—P. **Glangeaud**: The complexity of the volcanic massif of Cantal and the true nature of the Puy Mary. The author has been led to form a different opinion on the constitution of the Puy Mary from that currently held, and regards it as a true volcanic dome afterwards covered up by its products, and later uncovered by erosion.—C. **Lepierre**: A new type of mineral water: nitrate waters. Nitrates usually exist in waters in traces only, but an analysis of the water from Ericeira, Portugal, shows that nearly 19 per cent. of the total mineral matter in solution consists of nitrates. Of the various hypotheses as to the possible source of the nitrate, that of the nitrification of organic matter agrees best with the observed facts.—M. **Romieu**: The cytological and micro-chemical study of the red-blood corpuscles in the cœlom of *Terebella lapidaria*.—L. **Boutan**: The nucleus of fine pearls. The qualities of the surface of fine pearls are quite uninfluenced by the presence of a nucleus in the interior.—M. **Bodansky**: The distribution of zinc in the organism of the fish. Two fishes were selected, the catfish, *Ailurichtys marinus*, known to contain unusually large proportions of zinc, and the red snapper, *Lutjanus aya*, containing proportions of zinc normally present in animal tissues. The organs of these were dissected out and the amount of zinc in each determined. In the red snapper the maximum proportion of zinc was found in the spleen (43·5 mgr. per kg.) and liver (55·5 mgr. per kg.), with a minimum (2·3) in the muscles. In the catfish the minimum amount (8·1 mgr. per kg.) was also in the muscles, but the maximum was found in the gills (102·5 mgr. per kg.).—A. **Berthelot** and Mlle. E. **Ossart**: Researches on the micro-organisms producing acetone. Besides the active anaerobic organisms of A. Fernbach capable of utilisation on the industrial scale, there exist in Nature many other micro-organisms, both aerobic and anaerobic, capable of producing small quantities of acetone, and it is possible that some of these may penetrate and develop in the intestinal canal.—C. **Levaditi** and S. **Nicolau**: Immunity in neurotropic ectodermoses.—M. and Mme. G. **Villedieu**: The toxicity of metals for yeasts and moulds. In these experiments sheets of metal instead of the usual metallic salts were employed, the same nutrient solution being used in all cases. Starting with the least toxic, the metals came out in the following order: mercury, copper, zinc, iron, and magnesium, the last-named being the most toxic.—A. **Lumière** and H. **Couturier**: The desensibilisation of anaphylactised animals by means of several antigens. The results of the experiments detailed are not in accord with the view that vaccination by one antigen confers immunity against others. The anaphylaxy is really specific.—Mlle. Marthe **Giraud**, G. **Giraud**, and G. **Barès**: The hæmoclasic crisis due to the penetrating X-rays.

ROME.

Reale Accademia nazionale dei Lincei, June 3.—V. Volterra, vice-president, in the chair.—Papers by fellows:—C. **Somigliana**: Depth of glaciers, ii. A mathematical determination of the form of profile of the section of the glacier in terms of observations of its rate of flow at the surface.—F. **Severi**: Integrals of first species belonging to an algebraic surface, vi.—C. **De Stefani**: Fossil sponges, vii. The localities are the Crocetta group, the Palazzo Doria, and Rio Gea.—B. **Grassi**: Can malaria be transmitted directly by Anopheles? In three experiments a patient suffering from malaria was bitten by Anopheles which were afterwards allowed to attack a healthy subject. In each case they filled themselves and emitted a drop of blood, and it was evident that the conditions were favourable to inoculation, but the individuals who underwent the experiment remained immune.—A. **Stefani**: Physiology of nerves and nerve-centres (to be published later).—G. **Bruni** and E. **Romani**: Mechanical action of certain vulcanising accelerants of rubber. In this paper the authors have developed a general theory of the accelerative action of an important group of organic agents, both sulphurous and non-sul-

phurous.—Papers communicated through fellows:—J. **Pérès**: "Sur les fonctions permutables" (in French).—M. **De Angelis**: Crystalline forms of trimethylphloretin,

$$C_6H_2O_3(CH_3)_3\cdot CO\cdot CH(CH_3)\cdot C_6H_4OH.$$

—E. **Sereni**: Biochemistry of preparations from the central system of the frog.—An address was presented to Prof. Ernesto Mancini in commemoration of the fortieth anniversary of his nomination to the office of Chancellor of the Academy.

June 5.—Special meeting attended by the King.—The following prizes were awarded:—Royal prize for mathematics to Prof. Guido Fubini, of Turin; Royal prize for social and economic sciences to Prof. Gino Arias, of Genoa. Of the two prizes offered by the Minister of Public Instruction for physics and chemistry, one is awarded to Prof. Eligio Perucca and the other divided between Prof. Giuseppe Crestani and Mario Tenani. Two similar Ministerial prizes for philology are divided between Profs. Carlo Calcaterra, Massimo Lenchantin, De Gubernatis, Alfonso Omodeo, and Augusto Rostagni. The Carpi prize is awarded to Dr. Enrico Carano for his work on the embryology of Asteraceæ; the Sella prize to Dr. Antonio Sellerio, of Palermo; and the prize of the Morelli Institute to Dr. Camillo Ausenda. Prof. G. Vitelli gave an address on the composition of Homeric poems, and congratulatory addresses were exchanged with the British Academy.

June 19.—F. D'Ovidio, president, in the chair.—Papers by fellows:—G. **Castelnuovo**: Abelian functions, iv.: Applications to algebraic series of groups on a curve.—C. **Somigliana**: Depth of glaciers, iii. Determination of the profiles corresponding to expressions for the surface velocity of the second and third degrees as functions of the lateral co-ordinate.—F. **Severi**: Integrals of the first series of an algebraic surface, vii.—L. **De Marchi**: Thermal gradient and vertical acceleration in the atmosphere. In this paper the author investigates the vertical motion of the air as dependent on temperature conditions, condensation of raindrops, and other causes, and gives numerical values for the estimated velocity and acceleration under given assumed conditions. Apart from its meteorological significance, this investigation has an important bearing on another application which is, and has for a long time been, awaiting systematic study. While the vertical velocities of the air in the author's paper fall short of the values that would be necessary to maintain a bird in continuous horizontal gliding flight, they certainly suggest that under different conditions upward air-currents may be set up which are sufficient for the sustentation of gliding birds. Such conditions one would expect to occur in a country where the earth's surface is exposed to the action of tropical sunshine in daytime and is cooled at night by radiation in a cloudless sky. It is much to be hoped that the author's work will pave the way for further study of this interesting question.—C. **De Stefani**: Fossil sponges, viii. The localities under examination are at Crocetta, Casa Bisognaschi, and under the Casa Doria.—Communicated by fellows:—L. **Brusotti**: Small variation of a real algebraic plane curve.—G. De A. **D'Ossat**: Solubility of leucite in agricultural soil. These investigations show that leucite is not only soluble in water, but when mixed with soil it gives rise to reactions capable of liberating potash in considerable quantities—a result of great importance in its application to agriculture, as it is calculated by Washington that in Italy nine billion tons of potash contained in volcanic rocks are capable of being rendered available by this method.

The following papers were received during the vacation:—Papers by fellows:—C. **Somigliana**: Depth of glaciers, iv. (4th order profiles).—O. M. **Corbino**: Effect of magnetic field on heat conduction.—B. **Grassi**: A biological race of Anopheles which do not attack man; a very singular case of anophelism and paludism without malaria. In 1906 Prof. Giacomo Rossi, of the Higher School of Agriculture at Portici, directed attention to Orti di Schito (between Torre Annunziata and Castellamare) as an example of anophelism without malaria. The author on visiting the district found a "truly phenomenal" abundance of both *A. claviger* and *A. maculipennis*, sometimes rising in clouds at sunset and literally swarming in pigsties; on the other hand, malaria had been unknown for years. This result is now explained by the discovery that in this particular district the Anopheles never attack human beings. Observations extending over several visits both by the author and his assistants showed no case of anyone being bitten by the Anopheles, except when almost forced to do so by being previously kept in a state of starvation. On the other hand, the inhabitants of Schito were frequently bitten by Culex. The author suggests that this peculiar biological race of Anopheles acquired their present habits during a period (about 1860–70) when large flocks of cattle were kept in the marshy districts with very few men in charge of them.—Prof. B. **Morpurgo**: Consequences of nephrectomy in Siamese moles.—O. M. **Corbino**: Theory of Thomson effect.—G. **Bruni** and C. **Pelizzola**: Presence of manganese in grey rubber and cause of "tackiness" (*peciosità*). Analysis of various rubbers showed that good examples contained only an average of 0·16 milligram of manganese in 100 grams of rubber. In examples presenting strong uniform tackiness the proportion of manganese was 20 milligrams per 100 grams, while in intermediate cases, where the tackiness was slight and irregular, the proportion was usually from 1 to 3·75 milligrams per 100 grams. It thus appears probable that the decomposition of the rubber is in part due to the action of the manganese as an oxidising agent, this action being cyclic.—The following papers were communicated through fellows:—G. **Abetti**: Determination of longitude by wireless telegraphy.—E. G. **Togliatti**: Varieties of three dimensions and fourth order that are loci of at least infinity-squared lines.—Dr. B. **Peyronel**: *Menispora microspora*, n. sp., one of the Hyphomycetæ with mesoendogenous conidia. A new fungus forming minute spots on the bark of the chestnut, remarkable for the mode of formation of its conidia.—F. **Sibirani**: Bertrand's curves.—A. **Tanturri**: New expression of Bernoulli's numbers.—G. **Abetti**: Comparison between visual and photographic observations of nebulæ. In 1876–79 a number of drawings of nebulæ were made by G. Tempel at Arcetri with an Amici equatorial of 28-cm. aperture and 5·20 metres focal length. The author compares nine of these with photographs made by Pease with the 60-in. reflector of Mount Wilson. The agreement is very marked, thus confirming the accuracy of the drawings, but there appears evidence of relative displacements of the stars and nuclei in the interval between the observations, attributable to proper motions.—G. **Stefanini**: Geology of Cyrenaica, ii.—E. **Perucca**: Measure of differences of contact potential by the Lippmann-Pellat method.—M. **La Rosa**: Conductivity and thermo-electric power in a magnetic field on the electron theory.—G. **Agamennone**: The world's earthquakes in 1916. Taking as starting point H. H. Turner's British Association report, the author tabulates statistics showing how many of the "large" earthquakes were observed at each of the

five Italian stations of Rocca di Papa, Moncalieri, Padua, Montecassino, and Valle di Pompei for each month of 1916.—Dr. J. C. **Cortini**: *Tylomyces gummiparus*, n. sp., the prototype of a new genus of hyphomycetes, i. This fungus was found on some specimens of carnation that were attacked by Fusarium, and the author refers it to the family Dematiaceæ, section Phragmosporæ. The paper is illustrated by figures.—C. **Artom**: Cytological data on the tetraploidism of *Artemia salina* from the district of Margherita di Savoia, in Apulia. A development arising from a previous investigation, in which the author found that the Artemias from eighteen different localities were separable into two distinct groups, differing in the size of the nuclei of their intestinal cells.

Books Received.

Fundamental Catalogue of 1846 Stars for the Equinox 1900, from Observations made at the Royal Observatory, Cape of Good Hope, during the years 1912–1916, under the Direction of S. S. Hough. Pp. xxx+38. (London: H.M. Stationery Office.) 10*s*. net.

More Hunting Wasps. By J. H. Fabre. Translated by A. T. de Mattos. Pp. viii+376. (London: Hodder and Stoughton, Ltd.) 8*s*. 6*d*. net.

The Wonder Book of Science. By J. H. Fabre. Pp. 287. (London: Hodder and Stoughton, Ltd.) 8*s*. 6*d*. net.

Fluoreszenz und Phosphoreszenz im Lichte der Neureren Atomtheorie. By P. Pringsheim. Pp. viii +202. (Berlin: J. Springer.) In Germany, 48 marks; in England, 144 marks.

Modern Electrical Theory. By Dr. N. R. Campbell. (Cambridge Physical Series.) Supplementary Chapters. Chapter xv: Series Spectra. Pp. viii+110. (Cambridge: At the University Press.) 10*s*. 6*d*. net.

An Introduction to Psychology. By S. S. Brierley. Pp. viii+152. (London: Methuen and Co., Ltd.) 5*s*. net.

Exploration of Air: Out of the World North of Nigeria. By A. Buchanan. Pp. xxiv+258. (London: J. Murray.) 16*s*. net.

The Practical Chemistry of Coal and its Products. By A. E. Findlay and R. Wigginton. Pp. 144. (London: Benn Bros., Ltd.) 12*s*. 6*d*.

Modern Gasworks Practice. By A. Meade. Second edition, entirely re-written and greatly enlarged. Pp. xii+815. (London: Benn Bros., Ltd.) 55*s*.

Verhandelingen van Dr. P. Zeeman over Magneto-Optische Vershijnselen. Pp. xvi+341+14 plates. (Leiden: E. Ijdo.)

Annales de l'Observatoire Météorologique Physique et Glaciaire du Mont Blanc. Publiées sous la direction de J. Vallot. Tome vii. Pp. vi+240. (Paris: G. Steinheil.)

Diary of Societies.

THURSDAY, NOVEMBER 17.

ROYAL HORTICULTURAL SOCIETY, at 10—6.—International Potato Conference.

ROYAL SOCIETY, at 4.30.—Major P. A. MacMahon and W. P. D. MacMahon: The Design of Repeating Patterns.—Prof. J. W. Nicholson: A Problem in the Theory of Heat Conduction.—Prof. C. H. Lees: The Thermal Stresses in Spherical Shells Concentrically Heated.—R. A. Fisher: The Mathematical Foundations of Theoretical Statistics.—F. P. White: The Diffraction of Plane Electromagnetic Waves by a Perfectly Reflecting Sphere.—Prof. C. V. Raman and G. A. Sutherland: The Whispering Gallery Phenomenon.

LINNEAN SOCIETY OF LONDON, at 5.—Capt. A. W. Hill: Account of an Expedition to the Cameroons and Nigeria in 1921.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5 (Annual General Meeting).—S. Banach: An Example of an Orthogonal Development whose Sum is Everywhere Different from the Developed Function.—A. C. Dixon: Expressions and Functions Reduced to Zero by the Operator $\sinh D - cD$.—H. Hilton: Plane Curves of Degree $2n$ with Tangents having bi-n-point Contact—C. Krishnamachary and M. Bhimasena Rao: A Table of Values of 30 Eulerian Numbers, based on a new method.—L. J. Mordell: The Number of Solutions in Positive Integers of the Equation $yz+zx+xy=n$.—G. Pólya: Sur les séries entières à coefficients entières.—H. J. Priestley: Some Applications of Integral Equations to the Theory of Differential Equations.—W. F. Sheppard: Inverse Correspondence of Differences and Sums.—T. Stuart: The Parametric Solutions and Minimum Numerical Solutions of $x^3+y^3+z^3=w^3+v^3$.—R. Vythynathaswamy: Generating Regions of a Quadric in Space of n Dimensions.—B. M. Wilson: Proofs of some Formulæ enunciated by Ramanujan.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Col. F. Searle: Requirements and Difficulties of Air Transport.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—H. F. Collins: The Igneous Rocks of the Province of Huelva and the Genesis of the Pyritic Orebodies.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—E. S. Byng: Telephone Line Work in the United States.

CHEMICAL SOCIETY, at 8.—H. Burton and J. Kenner: The Influence of Nitro-groups on the Reactivity of Substituents in the Benzine Nucleus. Part V., Heteronucleal Dinitro-derivatives.—F. Challenger and J. F. Wilkinson: Organo-derivatives of Bismuth. Part V., The Stability of Halogen, Cyano-, and Thiocyano-derivatives of Tertiary Aromatic Bismuthines.—F. Challenger and L. R. Ridgway: Organo-derivatives of Bismuth. Part VI., The Preparation and Properties of Tertiary Aromatic Bismuthines and their Interaction with Organic and Inorganic Halogen Compounds.—O. Silberrad: Researches on Sulphuryl Chloride. Part I., Influence of Catalysts: A Convenient Method of Chlorinating Benzine.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at London School of Tropical Medicine), at 8.15.—Laboratory Meeting.

FRIDAY, NOVEMBER 18.

ROYAL HORTICULTURAL SOCIETY, at 10.30—1.30.—International Potato Conference.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botanical Lecture Theatre, Imperial College of Science and Technology), at 3.—Dr. E. J. Butler and others: Discussion: Meteorological Conditions and Disease.

INSTITUTE OF TRANSPORT (Graduates' and Students' Section) (at Royal Society of Arts), at 5.—J. P. Thomas: The Operation and Development of Urban Electric Railway Services.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 5.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Dr. E. H. Salmon: The Machinery of Floating Docks.

JUNIOR INSTITUTION OF ENGINEERS, at 7 (Annual General Meeting).

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 8.—J. D. Johnston: Photography in Relation to the Graphic Arts.

ROYAL SOCIETY OF MEDICINE (Electro-therapeutics Section), at 8.30.—Dr. F. Daels: (1) Histological Pictures of the Curing of Uterine Baso-cellular Epithelioma. (2) The Use of Drainage Tubes in the Irradiation of the Pelvis with Radium.—Dr. G. Fildes: Further Remarks on the Potter-Bucky Diaphragm.

SATURDAY, NOVEMBER 19.

BRITISH MYCOLOGICAL SOCIETY (in Botany Lecture Theatre, University College), at 11.—Dr. G. R. Bisby: The Use of Fungicides on Potatoes in North America.—Dr. W. Brown: The Growth of Fungi in Cultures.—W. N. Edwards: An Eocene Microthyriaceous Fungus from Mull, Scotland.—Dame H. C. I. Gwynne-Vaughan: The Grouping of the Simpler Ascomycetes.—Dr. A. S. Horne: Fungi from a Diseased Hevea Stem.

PHYSIOLOGICAL SOCIETY (at St. Thomas's Hospital), at 4.—J. N. Langley: Sweat Secretion.—W. E. L. Brown: An Independent Determination of the Value of "n" in Hill's Equation.—T. Lewis, C. C. Iliescu, and A. M. Wedd: A Paradoxical Effect of Vagal Stimulation upon the Auricles.—D. Noel Paton: The Significance of Digestion Leucocytosis.—F. R. Fraser: The Reaction of Human Blood in Cardiac and Renal Disorders by the Colorimetric Method.—A. V. Hill: The Maximum Work of Human Muscles.—A. V. Hill and J. C. Bramwell: The Velocity of the Pulse Wave.—Miss D. V. Atkinson: The Osmotic Pressure of Hæmoglobin in Blood.—E. C. Dodds and T. I. Bennett: Some New Observations on Diabetes Mellitus.—J. H. Burn: The Relation of Nerve Supply to Sweating produced by Pilocarpine.—J. Mellanby: Experimental Dyspnœa.

MONDAY, NOVEMBER 21.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—A. J. Hainsworth and others: Hydro-electric Power.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Meeting), at 7.—J. Harrison: Some Thoughts on Motor-cycle Engine Design.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Dr. F. W. Thomas: An Indian Doctrine of Perception and Error.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—G. H. Widdows: School Design.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—J. M. Wordie: Jan Mayen: An Old Arctic Volcano.

TUESDAY, NOVEMBER 22.

ROYAL SOCIETY OF MEDICINE (Medicine Section) (at St. Thomas's Hospital), at 4.45.

ZOOLOGICAL SOCIETY, at 5.30.—Dr. A. Smith Woodward: Exhibition of a Fossil Human Skull from Broken Hill, North Rhodesia.—Dr. C. F. Sonntag: Contributions to the Visceral Anatomy and Myology of the Marsupialia.—C. W. Hobley: The Fauna of East Africa and its Future.—H. Matsumoto: *Megalohyrax*

Andrews and *Titanohyrax*, g.n.: A Revision of the Genera of Hyracoids from the Fayûm, Egypt.

WOMEN'S ENGINEERING SOCIETY (at 26 George Street, W.1), at 6.15.—Miss Mary Abbott: Women and the Conquest of the Air.

QUEKETT MICROSCOPICAL CLUB, at 7.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—A. C. Braham: Demonstration of the Latest Developments and Improvements in the Carbro Process.

INSTITUTE OF INDUSTRIAL ADMINISTRATION, at 7.30.—H. Lesser: Unemployment Insurance for Individual Firms.

SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Essex Hall, Strand), at 8.—Dr. Marie Stopes, the Mayor of Islington, A. Harrison, and others: Resolution in Connection with Unemployment and Birth Control.

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group), AND INSTITUTION OF MECHANICAL ENGINEERS (at Institution of Electrical Engineers).—J. H. West: The Claude Synthetic Ammonia Process and Plant.

WEDNESDAY, NOVEMBER 23.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—R. P. White: Do We Neglect the Industrial Skin Sufferer?

ROYAL SOCIETY OF MEDICINE, at 5.—Dr. G. Monod: Syphilis of the Stomach. To be followed by Sir Berkeley Moynihan, Dr. C. Bolton, Dr. A. F. Hurst, Prof. McNee, H. Paterson, J. Sherren, and A. J. Walton.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—W. K. Earle: The Lower Carboniferous Rocks of West Cumberland.—W. G. St. J. Shannon: A Composite Sill at Newton Abbott (Devon).

ROYAL SOCIETY OF ARTS, at 8.—Prof. J. A. Fleming: The Coming of Age of Long-distance Wireless Telegraphy and Some of its Scientific Problems (Trueman Wood Lecture).

THURSDAY, NOVEMBER 24.

ROYAL SOCIETY, at 4.—Special General Meeting to consider the Annual Report of Council. At 4.30.—*Probable Papers*.—K. Sassa: (1) Observations on Reflex Responses to the Rhythmical Stimulation in the Frog. (2) The Effects of Constant Galvanic Currents upon the Mammalian Nerve-muscle and Reflex Preparations.—E. Ponder: The Hæmolytic Action of Sodium Glycolate.—Dorothy J. Lloyd and C. Mayes: The Titration Curve of Gelatine.—D. H. de Souza and J. A. Hewitt: Idio-Ventricular Periodicity.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. C. Hay-Murray: Phrenology as an Aid to Education.

CONCRETE INSTITUTE, at 7.30.—E. F. Etchells: Presidential Address.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—Prof. F. J. Cheshire: Polarising Apparatus.

ROYAL MICROSCOPICAL SOCIETY (Metallurgical Section), at 7.30.—C. W. Hawksley and P. Swift: Various Types of Vertical Illuminators.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—Discussion on Renal Function Tests.—*Short Opening Papers* by J. J. Everidge, J. S. Joly, J. B. Macalpine, Dr. MacLean and C. Nitch, Dr. M. Wallis and G. Ball. To be followed by Sir Cuthbert Wallace, Dr. L. Brown, F. Kidd, Dr. Marrack, G. E. Neligan, A. E. Webb-Johnson, and A. C. Morson.

FRIDAY, NOVEMBER 25.

ROYAL SOCIETY OF ARTS (Dominion and Colonies and Indian Sections, Joint Meeting), at 4.30.—A. H. Ashbolt: An Imperial Airship Service.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—Hygrometry: Dr. E. Griffiths, F. J. W. Whipple, Principal Skinner, W. Watts, Dr. G. A. Shakespear, Prof. A. M. Tyndall, H. G. Mayo, and Prof. A. P. Chattock. Followed by a discussion to be opened by Sir Napier Shaw.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section), at 5.—Miss Eva Morton: Report on a Fatal Case of Bullous Eruption.

INSTITUTION OF PRODUCTION ENGINEERS (at Institution of Mechanical Engineers), at 7.30.—A. F. Guyler: Drawings and Production.

JUNIOR INSTITUTION OF ENGINEERS, at 8.—G. F. Shotter: Electromagnetic Instruments: Problems in their Design and Construction.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.—Dr. J. P. Kinloch: Metabolism in Fevers.

PUBLIC LECTURES.

(A number in brackets indicates the number of a lecture in a series.)

THURSDAY, NOVEMBER 17.

UNIVERSITY COLLEGE, at 5.—Prof. J. E. G. De Montmorency: The Background of Non-European Feudalism (3).

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—W. Bateson: Recent Advances in Genetics (3).

BIRKBECK COLLEGE, at 7.30.—Prof. F. Soddy: The Bearing of Physical Science on Economics (2).

FRIDAY, NOVEMBER 18.

UNIVERSITY COLLEGE, at 4.30.—Dr. J. C. Drummond: Nutrition (6).

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Dr. J. D. Falconer: The Wonders of Geology (Swiney Lectures) (6).

UNIVERSITY COLLEGE, at 8.—Prof. G. Dawes Hicks: Our Knowledge of the Real World (3).

MONDAY, NOVEMBER 21.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Dr. J. D. Falconer: The Wonders of Geology (Swiney Lectures) (7).

KING'S COLLEGE, at 5.30.—Dr. W. R. Ormandy: Liquid Fuel Engines (3).

TUESDAY, NOVEMBER 22.

KING'S COLLEGE, at 5.30.—Prof. H. Wildon Carr: The Modern Scientific Revolution and its Meaning for Philosophy (7); The Pragmatic Theory of the Intellect.—Dr. W. Brown: Psychology and Psycho-therapy (6).

WEDNESDAY, NOVEMBER 23.

KING'S COLLEGE, at 4.30.—Dr. C. Da Fano: Histology of the Nervous System (7).

SCHOOL OF ORIENTAL STUDIES, at 5.—Miss Alice Werner: The Swahili Poem on the Ascension of the Prophet.

UNIVERSITY COLLEGE, at 5.—Prof. G. Elliot Smith: The Evolution of Man (1).

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Dr. J. D. Falconer: The Wonders of Geology (Swiney Lectures) (8).

THURSDAY, NOVEMBER 24.

UNIVERSITY COLLEGE, at 2.30.—Miss M. A. Murray: Ancient Survivals in Modern Egypt.

UNIVERSITY COLLEGE, at 5.—Prof. J. E. G. De Montmorency: Feudalism in India (4).

BARNES HALL (1 Wimpole Street, W.1), at 5.15.—Prof. E. C. Van Leersum: Dietetics and Public Health (Chadwick Lecture).

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—W. Bateson: Recent Advances in Genetics (4).

KING'S COLLEGE, at 5.30.—H. W. Fitz-Simons: Bridge Construction (4).

FRIDAY, NOVEMBER 25.

UNIVERSITY COLLEGE, at 4.30.—Dr. J. C. Drummond: Nutrition (7).

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Dr. J. D. Falconer: The Wonders of Geology (Swiney Lectures) (9).

UNIVERSITY COLLEGE, at 8.—Prof. G. Dawes Hicks: Our Knowledge of the Real World (4).

SATURDAY, NOVEMBER 26.

UNIVERSITY COLLEGE, at 10.30.—Prof. Karl Pearson: Fallacies (Lectures for Teachers).

CONTENTS.

	PAGE
University Grants	361
Psychological Medicine	362
British Mammals. By J. G. M.	364
Plant Biochemistry	364
Our Bookshelf	365
Letters to the Editor:—	
Metallic Coloration of Chrysalids.—The Hon. H. Onslow	366
The Softening of Secondary X-rays.—Prof. Arthur H. Compton	366
The Colour of the Sea.—Prof. C. V. Raman	367
The "Proletarisation of Science" in Russia.—Prof. Bohuslav Brauner	367
Biological Terminology.—J. T. Cunningham	368
Reflection "Halo" of (Semi-)Cylindrical Surfaces. (*With Diagram.*)—J. H. Shaxby	369
Microscope Illumination and Fatigue.—H. J. Denham	369
The Aurora Borealis of September 28–29.—Major William J. S. Lockyer	370
Applied Anthropology.—Dr. N. Annandale	370
Use of Carborundum for Ruling Test Plates.—W. G. Cady	370
Bee-sting and Eyesight.—J. W. Gifford	370
The Age of the Earth.—Dr. Harold Jeffreys	370
A New Cave Man from Rhodesia, South Africa. By Dr. Arthur Smith Woodward, F.R.S.	371
Problems of Physics. By Prof. O. W. Richardson, D.Sc., F.R.S.	372
The Botanic Gardens, Victoria, Cameroons Province, Nigeria. (*Illustrated.*)	377
Obituary:—	
Dr. F. W. Passmore	379
Dr. Oscar Montelius	379
Notes	380
Our Astronomical Column:—	
Bright Assemblage of Morning Stars	384
Medieval Astronomical Instruments in India	384
Nova Aquilæ	384
British Scientific Instrument Research Association	385
Arctic Medusæ	385
University and Educational Intelligence	386
Calendar of Scientific Pioneers	387
Societies and Academies	388
Books Received	391
Diary of Societies	391

THURSDAY, NOVEMBER 24, 1921.

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Britain's Food Supply Basis.

THE papers read at the successful International Potato Conference held in London last week indicated the many points of interest which the potato presents for plant pathologists, breeders, and cultivators; but there was no topic discussed by the experts, who dealt with the technical problems presented by the crop, which has so much interest for the general public as the place which the potato should take in our national food economy. To this subject close attention has recently been directed in connection with the uses of the potato in time of war.

In a paper read before the Agricultural Section of the British Association at the Edinburgh meeting last September and now published in pamphlet form,[1] Lord Bledisloe remarked:—

"During the late war it was assumed by practically the whole British population . . . that bread made of wheat flour was the unalterable staff of life. . . . I desire to propound the view that, in a like emergency, potatoes, supplemented by pig-meat and a larger output of milk, would probably afford a less precarious basis for Britain's food supply than wheat, and a better insurance against national starvation."

Lord Bledisloe marshals his points with much ability and industry, and he sets them out in a series which, if the public's right to self-determination in the matter of diet had been admitted, would have numbered exactly fourteen! In an emergency, however, there can be no self-determination, and so we have the whole case for potatoes and pigs; but there is little regard for the counter-claims of wheat, and none at all for the merits of oatmeal, an omission one would not have expected in an address delivered so close to the Heart of Midlothian!

Let us first take the case stated for potatoes. The crop is far more productive than wheat, yielding twice as much energy per unit of area. It can be grown successfully in every part of the United Kingdom, whereas wheat is suited to the dry eastern and southern counties. Potato cultivation is simple—every farmer and every allotment holder has grown this crop; with wheat cultivation many farmers are "wholly unfamiliar." Home-grown potatoes would be safe from the risks of marine transport; there were heavy losses in sea-borne wheat in 1917. Potatoes, grown everywhere, could be used locally, thus reducing transport; in preparation for long journeys "desiccation of the tubers" might be resorted to. Wheat is exposed to the incendiary bomb of the airman and to the pitiless rain of the British climate; the potato is safe underground, and though blight may appear its effects may be minimised by spraying. (But is the potato a safer crop than wheat? Have we already forgotten 1916? Was it the Corn Law only that was "rained away" in the middle of the 'forties? What was William Cobbett thinking about when he "resolved, fire or fire not, that working men should not live upon potatoes in my country"?)

With potatoes the pig is naturally associated; it may be fed on spoiled or sound tubers; it makes meat more economically than any other domestic animal, its flesh supplies the protein and the fat required to supplement the starchy potato.

The pig and potato policy was, of course, the outstanding pre-war feature of German agriculture, and Lord Bledisloe makes a conservative estimate of its effect on the endurance of that nation when he expresses the opinion that, but for its potato crop, German resistance would have broken down a year before November, 1918.

It is not quite clear how far Lord Bledisloe would propose to carry the substitution of potatoes for wheat. He would not reduce the British corn area, but, from the estimates which he presents, he appears to think that, by extending potato cultivation, our wheat importation during war might be reduced by at least 50 per cent., and even be abandoned altogether, for he states that 1,280,000 acres under potatoes would provide food equivalent to half our wheat imports, and that by

[1] "Potatoes and Pigs with Milk as the Basis of Britain's Food Supply." By Lord Bledisloe. (With some Hints as to the Production of Each.) Pp. 59. (London: Hugh Rees, Ltd., 1921.) 1s. net.

doubling this area and making some increase in pigs we could do without any importation of wheat.

There is much to be said in favour of a potato and pig programme in war, as German experience proves. We ourselves did everything possible to increase the potato area during the war, and though Lord Bledisloe suggests that we vacillated in the matter of pigs, this was inevitable. Every belligerent European nation vacillated in its pig policy, the Germans included. This class of live stock requires extraordinarily close watching; it easily becomes a danger, and in some stages of the war it may be questioned if there was any animal in Europe that served the Allied cause better than the German pig. The management of swine led to violent controversies between the agrarian and the urban population; eventually a pig holocaust was necessary to save the lives of the unfortunate city dwellers. German experience, indeed, does not wholly support Lord Bledisloe's proposition, for even their enormous potato crop —which before the war was three or four times greater than was necessary for human use—played them false. The storage and transport difficulties were immense, there were great losses from frost, and we cannot have forgotten the tales of woe caused by the indigestible kohlrabis which were used to supplement the scanty potato supply. Potatoes may be productive and highly valuable to nations at war, but no crop is more difficult to deal with; the echoes of the German Food Controller's language, when he discussed his potato problems in public, reached us here; and attentive listeners might have discovered that the perplexities presented by the potato excited even our own Food Controllers!

In the course of a great war it might be possible to stimulate potato cultivation to an extent that would reduce corn imports by 25 or 30 per cent., but to achieve the results proposed by Lord Bledisloe it would be necessary to follow the German example and in peace time learn to cultivate and use three or four times as large a quantity as our markets now call for. But it is certain that the farmer would find potato growing for such industries as distilling or starch making very much less profitable than corn growing. Pig feeding would pay better than alcohol or farina, but when the human consumer can barely afford the price necessary to maintain the existing acreage, what prospect is there of a threefold extension of potato growing for pigs?

The present position suggests a decrease rather than an increase in the area of potatoes grown for market. Since the Armistice a change has come over the prospects of the crop. The great rise in the cost of transport and of fuel makes this foodstuff no longer cheap to the urban consumer. In London potatoes are now being sold retail at from 1*s*. 9*d*. to 3*s*. per 14 lb. At 2*s*. the cost of energy would be about 225 Calories per penny; in the 4-lb. loaf at 10*d*. energy can be bought at about 400 Calories per penny, and potatoes must be cooked. There has therefore been a decline in consumption. The large drop in the percentage of the retail price of potatoes and other vegetables now received by the farmer, because of the increase in transport and marketing costs, is a serious matter for the consumer, as well as for the farmer. It means that the market demand has become much less effective than formerly in providing a supply. Until we can greatly reduce the cost of bringing the potato from the farm to the urban consumer the prospect of increasing the area under potatoes as desired by Lord Bledisloe is not encouraging.

Pigs form a more hopeful subject; there is great scope for their increase in peace time. Their place in war is less certain. In any long war we should probably have to ask ourselves whether fat pigs could be allowed to exist alongside a nation of lean people. There would always be advocates for both, but ultimately, as in Germany, the lean people would prevail.

Priestley in America.

Priestley in America, 1794–1804. By Prof. Edgar F. Smith. Pp. v+173. (Philadelphia: P. Blakiston's Son and Co., 1920.) 1.50 dollars net.

PROF. EDGAR SMITH, of the University of Pennsylvania, in studying the lives of early American chemists, naturally encountered the name of Priestley, who, as is well known, left this country for America in 1794. The odium and insult he had met with as a Dissenter culminated in the Birmingham Riots of 1791, when, to the cry of "Church and King," his house was wrecked and set on fire "with the most savage and determined fury," and the books and apparatus which it had been the business of his life to collect and use were utterly destroyed. What Pitt termed "the effervescence of the public mind" was kept alive by the implacable resentment of the great body of the clergy of the Established Church, aided by the speeches in Parliament

of Burke, and by what were then known as "Treasury newspapers," controlled by the political party in power. Priestley's position in this country became so insecure that eventually he determined to leave it and to join his sons, who with certain other persons, mainly Englishmen, were projecting a settlement near Northumberland at the confluence of the north-east and west branches of the Susquehanna. On April 8, 1794, he and his wife sailed from London, and arrived at the Old Battery, New York, on the evening of June 4.

The good ship *Sansom*, under Captain Smith, was not a very speedy craft to require fifty-seven days to cross the Atlantic, and her hundred passengers, with scant provision for their comfort, must have had a weary time of it. Priestley, however, in spite of occasional seasickness, occupied himself, as was his wont, with books. He relates that he read the whole of the Greek Testament and the Hebrew Bible as far as the first Book of Samuel; also Ovid's Metamorphoses, Buchanan's Poems, Erasmus's Dialogues, Peter Pindar's Poems, etc. To amuse himself he tried the temperature of the water at different depths, and made other observations which suggested experiments to be prosecuted whenever he should be able to re-establish his laboratory. To solace him he had received sundry parting gifts, among them "an elegant silver inkstand" from "three young gentlemen of the University of Cambridge," who regretted that such an "expression of their esteem should be occasioned by the ingratitude of their country." Also a characteristically florid and highly rhetorical valedictory address from the Society of United Irishmen of Dublin, enjoining him to pray for the patriots who, like him, were about to cross the bleak Ocean to a barbarous land—victims of "purblind statesmen" like Mr. Pitt.

Priestley was well received in America. His fame as a man of science had preceded him, and his well-known warm friendship for Franklin was in his favour. Indeed, it was generally acknowledged that this friendship reacted powerfully upon Priestley's work as a political thinker and as a natural philosopher. The *American Daily Advertiser*, in an editorial article of welcome, declared that it afforded

"the most sincere gratification to every well-wisher to the rights of man, that the United States of America, the land of freedom and independence, has become the asylum of the greatest characters of the present age who have been persecuted in Europe, merely because they have defended the rights of the enslaved nations. . . . The citizens of United America know well the honourable distinction that is due to virtue and talents; and while they cherish in their hearts the memory of Dr. Franklin, as a philosopher, they will be proud to rank among the list of their illustrious fellow-citizens, the name of Dr. Priestley."

For some days after their arrival the travel-worn voyagers were busily occupied in receiving visits from the principal inhabitants of New York and in replying to addresses of welcome from corporate bodies and societies in the State. These addresses, together with Priestley's replies, occupy a considerable section of Prof. Smith's book. The general character of the addresses is very similar. There is much about the arm of tyranny, corrupt Governments, venal Courts, an imperious and uncharitable priesthood, etc., all contrasted with liberty and equality and the system of beauty and excellence and "of virtuous simplicity" which characterised the happy Republican Government of America, where Reason had triumphed over the artificial distinctions of European policy and bigotry, and "where Providence had unfolded a scene as new as it is august, as felicitating as it is unexampled." Priestley's replies were couched, as might be expected, in less turgid rhetoric; but it is obvious from their terms that he was much affected by and grateful for the warmth of his welcome.

Amidst the general chorus there was, however, one dissonant note. It came from William Cobbett, and was sounded with characteristic violence. His pamphlet, "Observations on the Emigration of a Martyr to the Cause of Liberty," was a scurrilous attack on Priestley. It was the first of a series of lampoons signed "Peter Porcupine," mainly directed against American statesmen, which resulted in convictions for libel, and Cobbett was forced to leave the country.

After a fortnight's stay in New York Priestley moved to Philadelphia, then the seat of Government, where he was welcomed by the American Philosophical Society, which had been founded in 1727 by his friend Franklin. But Philadelphia had few attractions for him. He found it "unpleasant, unhealthy and intolerably expensive"—"only a place for business and to get money in," and he soon moved to Northumberland, where, with the exception of an occasional visit to Philadelphia either to lecture or to preach, he remained to the end of his days. He was invited to accept a professorship of chemistry in the Medical College of Philadelphia, but as this would require his residence for at least four months of the year in that city he declined it.

At Northumberland he occupied himself in help-

ing his youngest son, Henry, to clear the land, in planning his new house, working at his "Church History," and occasional experimenting. Towards the end of 1795 he sent papers to the American Philosophical Society on the analysis of atmospherical air and on the generation of air from water, which filled twenty quarto pages of vol. 4 of the Transactions of that learned body. These papers have little or no scientific value: their main interest consists in the fact that they were the first contributions he made in America to the literature of chemistry. As was the case with all his papers, they were written in the language of phlogistonism, and Stahl's doctrine was already on the wane, even in Young America. In the same year Priestley lost his favourite son, Henry. It was a bitter blow, from which neither he nor his wife ever wholly recovered. Indeed, from this time Mrs. Priestley's health steadily declined, and nine months later she, too, passed away. She was a woman of remarkable fortitude and strength of character, generous and affectionate, and a true helpmate to her husband. Her great-granddaughter, Madame Belloc, has paid a worthy tribute to her memory.

There were now rumours that Priestley intended to return to England, or at least to Europe, and he actually contemplated taking up his residence in France. It is doubtful whether he was ever wholly reconciled to his life in America. He said himself: "Here, though I am as happy as this country can make me . . . I do not feel as I did in England." He had occasional fits of depression—all the more remarkable for a man of his usually serene and equable temperament. He felt, too, that his "character as a philosopher was under a cloud." Phlogistonism was a lost cause, and, in spite of his efforts to keep it alive, he understood quite well, as Prof. Smith says, that "the entire chemical world was against him." Experimenting was now irksome to him, and, as he states, he became "quite averse to having his hands so much in water"; moreover, Priestley was an eminently sociable being, and he had little congenial society in Northumberland.

He simply hungered for letters from his friends in England. He wrote to Lindsey: "I cannot express what I feel when I receive and read your letters. I generally shed many tears over them." He turned more and more to theology, interested himself in the politics of the country, although he took no active part in them, wrote on public education and on the organisation of the college which President Jefferson contemplated for the State of Virginia. He was still, at times, drawn to science, for he had fitted up a small laboratory adjacent to his house, and the experimental work he did in it was embodied in "Six Chemical Essays," which were communicated to the American Philosophical Society and are printed in their Transactions. The essays consist of miscellaneous observations of no special scientific value. Indeed, it must be admitted that Priestley's chemical work in America added little to his scientific reputation. The laboratory, a small wooden building, remains much as he left it. It will shortly be removed to the Campus of Pennsylvania State College, where it will be preserved as a memorial to the famous chemist. Much of the apparatus is, however, in the possession of Dickinson College (Pa.). It is to be hoped that it will be ultimately deposited in the laboratory—surely the most fitting place for it. It would add greatly to the historic interest of the memorial.

It was on the piazza of Priestley's dwelling-house that the men who assembled on August 1, 1874, to celebrate the centenary of the discovery of oxygen, then and there founded the American Chemical Society.

The opening year of the new century found Priestley suffering from the infirmities of age. He was now nearly toothless, which, together with his incurable stutter, added to his difficulties of speaking. Moreover, his sense of hearing became impaired, and he was obliged to use an ear-trumpet. He was, however, thankful that his eyes did not fail him. During one of his visits to Philadelphia he had an attack of pleurisy, and for a time his life was in danger, while occasionally he suffered from ague. He said of himself:

"Tho' I was never robust, I hardly knew what sickness was before my seizure in Philadelphia, but the old building has since that had so many shocks, that I am apprehensive it will ere long give way. But I have abundant reason to be satisfied, and shall retire from life *convivа satur.*"

His apprehensions were soon to be realised. In the spring of 1803 he had a dangerous fall, and strained the muscles of the thigh, and for a time was obliged to use crutches. He suffered from the cold of the winter of 1804, and again contracted pleurisy, from which he died on February 6, in the seventy-first year of his age, breathing his last in the act of correcting a proof-sheet.

Prof. Edgar Smith gives the fullest and best account of Priestley's life in America which has yet appeared. He seems to have tapped every available source of information, and has had access to many letters and memoranda hitherto

unpublished. The book serves to complete the life-history of one who has been styled a "hero and type of the intellectual energy of the eighteenth century," and whose name, in spite of his errors and his misguided loyalty to a false philosophy, is imperishably fixed in the annals of science. T. E. THORPE.

The Actinomycetes.

Morphologie und Biologie der Strahlenpilze. (Actinomyceten.) By Prof. Rudolf Lieske. Pp. ix + 292 + Tafel 4. (Leipzig: Gebrüder Borntraeger, 1921.) 108 marks.

THIS volume by Prof. Rudolf Lieske, of the Botanical Institute at Heidelberg, on the morphology and biology of the Actinomycetes, forms a valuable addition to the literature of this subject. In a general introductory chapter there are an account of the occurrence of Actinomycetes in Nature and an annotated list of recorded species, references being given to original descriptions. This section also contains a discussion of the relation of Actinomycetes to Bacteria, Mycobacteria, Hyphomycetes, etc., the conclusion—from which many of us would dissent—being that the former are a primitive stem from which the latter have been derived.

The second section, dealing with the morphology of Actinomycetes, suffers from the lack of a thorough comparative study of growth forms under different standardised conditions. Still, Prof. Lieske approaches his subject with a more experimental and dynamic attitude of mind than that of a recent American investigator of Actinomycete morphology, and his results are correspondingly enlightened. In the study of higher organisms there has been developed a physiological anatomy; in the study of lower organisms perhaps our greatest need is a physiological morphology. When we abandon teleology and learn to interpret shape and structure in terms of physico-chemical relationships we shall begin to build a true micro-organismal morphology. The Actinomycetes would be a good group on which to commence. Prof. Lieske finds that they possess a true mycelium with typical monopodial branching, and "Luftsporen" are formed endogenously. The questions of cell nuclei and a possible primitive sexuality are left open, but it is disappointing to find "involution forms" dismissed as merely teratological growths—surely mycologists and bacteriologists have too long been content with this futile label.

The third section, dealing with the physiology of Actinomycetes, is perhaps the best, but again suffers from a too timid and unimaginative viewpoint. There is the usual consideration of the relation of the organisms to carbon, nitrogen, etc.—all useful data; but the very important enzymic relations of Actinomycetes, their antagonistic or additive reactions with other micro-organisms and their function in the soil economy, the very interesting pigments produced—these and other vital issues are treated too summarily. The fourth section deals with animal and human diseases such as "Madura foot," "lumpy jaw," etc. There is also a useful summary of methods of staining and the preparation of specimens. The last section of eight pages concerns the Actinomycetes in their relation to higher plants, and is merely a very inadequate account of potato scab and the root nodules of the alder. The work closes with a bibliography of 378 titles, of which 322 are German, while important works such as Poncet's comprehensive monograph are omitted.

The most serious difficulty in the study of Actinomycetes is the specific determination of the organisms isolated, and here Prof. Lieske's work gives no help. It needs to be supplemented by Drechsler's beautiful drawings in the *Botanical Gazette* and Waksman's cultural data in the *Journal of Bacteriology*. The book is finely produced with 114 text illustrations and four beautifully coloured plates, and in spite of its defects is a very valuable addition indeed to the literature of this important and obscure group of organisms.

W. B. BRIERLEY.

Emin Pasha's Last Collections.

Die Tagebücher von Dr. Emin Pascha. Herausgegeben mit Unterstützung des Hamburgischen Staates und der Hamburgischen Wissenschaftlichen Stiftung von Dr. Franz Stuhlmann. Band 6, *Zoologische Aufzeichnungen Emin's und seine Briefe an Dr. G. Hartlaub bearbeitet von Prof. Dr. H. Schubotz.* Pp. viii + 301. (Hamburg und Braunschweig: Georg Westermann, 1921.) 200 marks.

THE volume under review gives us notes, mainly ornithological, on the last collections made by this remarkable German-Jewish explorer in the equatorial Egyptian Sudan, including the south-eastern part of the Bahr-al-ghazal region, the Latuka-Lango district, and the north-west coast of the Albert Nyanza; but the author treats also of birds and mammals which have come under his observation in the countries between the south shores of the Victoria Lake and

the Zanzibar coast. His correspondence ceases with the middle of 1890. It contains interesting allusions to Dr. Sclater and other English ornithologists, to Dr. Junker, and to members of Stanley's expedition, and a rather pathetic touch in his own assumption of the *rôle* of the Wandering Jew.

Though this volume deals mainly with the birds of equatorial East Africa, it has some very interesting notes on the mammals. Emin had become aware of the presence in East Africa proper of a striped form of hyena, unknown to him in any survey of the Upper Nile regions. More than this—he has noted hints as to the existence in the Mangbettu or Mabode country, within the north-eastern limits of the Congo basin, of some type of "zebra." There is no zebra—so far as we are advised—within the limits of the Congo basin, or west of Tanganyika, or even of the main stream of the Nile. No type of equine—zebra or wild ass—has been seen west of the Nile within the Bahr-al-ghazal basin. It is clear that these scraps of information reaching Emin indicated not any zebra, straying beyond the habitat of this striped horse, but the okapi.

Dr. Junker, about 1886, wrote a note or two about a large antelope which was found in the southern part of the Mangbettu country, and which had a portion of its hide curiously striped. He seems to have been aware that the creature had cloven hoofs, and therefore did not style it a zebra; but he had evidently seen the strips of striped skin on the limbs of the okapi with which the forest negroes decorated their bodies. Stanley in 1889 heard stories of the okapi from the pigmies, and styled it "a large donkey." This volume will be of very great interest to ornithologists. H. H. JOHNSTON.

Our Bookshelf.

The Clayworker's Handbook. By A. B. Searle. Third edition, revised, enlarged, and largely rewritten. Pp. viii+381. (London: C. Griffin and Co., Ltd., 1921.) 21*s.*

THIS handbook is a useful compilation from catalogues, journals, year-books, etc. There is little or no attempt to show the original sources, and special work like that due to Mr. Bernard Moore is incorporated without reference to the discoverer. For the protection of the author himself, it would have been better had he given the authorities for some of the extraordinary statements made. There are so many of these that the book wants using with some caution. For example, it is said that "ball clay should not leave any residue on a sieve of 120 holes per linear inch." Anyone familiar with ball clays knows that this is wrong, and anyone not familiar with those clays would appear foolish if he rejected a delivery on this authority. We are also told that "enamels are always opaque," and there are several other misleading statements of like calibre. The table of common chemicals and their scientific names and formulæ would be much improved if it was revised by a chemist, for some of the scientific names are hopeless, likewise the formulæ. For example, "sodalite" (common term) is "a felspar" (scientific term); gypsum and plaster are both given the formula $CaSO_4 \cdot 2H_2O$, and the same mistake is made higher up the page, while flint is given as amorphous silica. Some of the names of defects are translated literally from the German, instead of into the terms generally employed in this country.

The book serves a useful purpose; the data are handy for reference, and they are skilfully arranged. It is with the object of getting it seriously overhauled that the unpleasant task of emphasising some of the mistakes has been undertaken.

Liverpool Marine Biology Committee: L.M.B.C. Memoirs on Typical British Marine Plants and Animals. Edited by Prof. W. A. Herdman and Prof. J. Johnstone. No. 24, *Aplysia.* By Nellie B. Eales. Pp. viii+84+7 plates. (Liverpool: University Press, 1921.) 4*s.* 6*d.*

THE present is the twenty-fourth Memoir, published after a considerable interval, of the well-known L.M.B.C. series. The animal with which it deals is a member of the Opisthobranchiata, one of the two orders of Euthyneura, to the other of which, the Pulmonata, belong the ordinary land snails. Though one of these latter animals is very usually studied in the laboratory as an example of Gastropoda, Aplysia presents several advantages as a type for dissection. It is the largest British Gastropod. It exemplifies a number of morphological tendencies, and exhibits intermediate characters between the primitive and more specialised forms. Its internal organs "afford numerous links in the chain of evidence that detorsion has taken place." The palliovisceral nerve cords are long (as in Streptoneura), but uncrossed (as in Euthyneura in general); the nervous system is less markedly concentrated than in many other Euthyneura, and the animal exemplifies the tendency to disappearance of the shell and mantle-cavity.

The present account will be useful as a laboratory guide; directions for dissection are given, intercalated in brackets at the necessary places in the anatomical description, and the plates are adequate in number and clearly drawn. An interesting section on the history of our knowledge of the animal is prefixed.

The first line of the book contains a curious inversion ("The Mollusc of which the present Memoir is the subject"); and the word "factors" on p. 41 (for "tributaries") reads awkwardly.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Metaphysics and Materialism.

In his article in NATURE of October 20 Prof. Carr maintains that the principle of relativity has "reformed" the concept of physical reality, and has finally made untenable the doctrine that matter is real. I dissent most strongly from his conclusion. If "real" is used in the only sense in which a belief in the reality of matter ever has been part of physics, that belief is entirely unaffected by the principle of relativity, which involves the belief as much as any other physical proposition. There may be senses of the word "real" in which the doctrine that matter is real is affected by the acceptance of the principle of relativity, but they are either repugnant to physics or irrelevant to it. I have explained my reasons for this opinion at length elsewhere, but at such length that nobody seems inclined to read them. May I be allowed to set them out rather more concisely?

First, then, Prof. Carr will admit that "real" is used in at least two senses. He presumably smiled when first he heard the old story of the mongoose which was as unreal as the snakes it was kept to kill. If he could understand "real" only in the metaphysician's sense, he would not, being an idealist, see any point in the story, for he would assert that every mongoose and every snake was unreal. The reality which the traveller denied to his mongoose was the reality of common sense, not the reality of metaphysics. The criterion of this common-sense reality is universality of experience. The snakes were not real because the experience of them was limited to the intemperate friend; other people could not experience them. The mongoose was unreal because if the box were opened nobody would experience it. If Prof. Carr were to say that he does not know what I mean by "universality of experience" in this connection, I fear I should simply disbelieve him; for the whole of his normal life shows that he recognises and applies the criterion like anybody else, materialist, idealist, or physicist.

The "real" of common sense is the fundamental "real" of science. A belief that there are real things in this sense (which might be, but is not usually, expressed by the assertion that matter is real) is necessary to science. It is necessary not so much in order that science should be true as in order that there should be any science. For real things in this sense are the subject-matter of science. Science selects the material it will study by applying the criterion of universal experience. It rejects from its subject-matter the snakes which only the traveller's friend could see; it accepts only such snakes as everybody can see. It is as absurd to ask whether students of science are right to employ this criterion as to ask whether Greek scholars are right to accept the universal practice of Greek writers; if we applied any other criterion our study would not be experimental or natural science.

In so far as the principle of relativity leads to any conclusions relevant to experimental science, it depends on this criterion as much as other scientific theory; the only observations with which its conclusions must be in accordance, if the principle is to be accepted as true, are observations concerning which everyone agrees. Sir Oliver Lodge does not differ from Prof. Eddington concerning the distribution of the spots on the Principe plates, and both of them would agree that, if they did differ as to that distribution (say, because the spots were very diffuse), the plates would not afford any evidence on which to base any scientific conclusion whatever. They agree that the plates must satisfy the criterion of scientific reality before they can proceed to differ in their interpretation of the plates. Nor would any difference between them in the matter of scientific reality arise even if the hypothetical experiments of which Prof. Eddington is so fond could actually be tried (I hold that it is most important to insist that they cannot be tried), and if it were found that two observers travelling with great relative velocity differed concerning the simultaneity of events. They would both agree that the observers did differ; and they would agree that, because of this difference, the judgment of neither could be accepted as a valid basis for scientific argument unless one or both could be "corrected" in some manner so as to remove the discrepancy. The position which would arise would be precisely similar to that which arose when first it was noticed that observers at different distances from a gun differed concerning the simultaneity of flash and report. Some observations which had been expected to be "real" would have turned out to be "unreal," but enough real observations, concerning which agreement could be obtained, would remain (if anything can be predicted about an event which cannot occur) to make science possible, even as applied to the discrepant observations (*cf. Phys. Zeit.*, vol. 13, p. 126, 1912).

So much for "real" in its fundamental sense. But physicists also use the word in another sense when they speak of electrons or atoms or the æther being real. This sense is not the fundamental sense, because nobody has perceived or could perceive an electron, and because people do actually differ about the reality of some of these things (*e.g.* the æther). Fortunately, there is no need to discuss in detail here the significance of this kind of "reality," for no physicist would assert in this sense that "matter is real." If matter is something different from, but common to, electrons, atoms, and æther, then science does not assert, but most strenuously denies, that such matter has any "reality." And that conclusion, again, is perfectly independent of the principle of relativity.

On the other hand, the principle of relativity might have a bearing upon reality in this sense, though not on the reality of matter. For to assert that something is real in this sense is to say that some theory is believed to be true; if we believe the theory of relativity to be true, we may assert that some things are real which we shall assert are not real if we do not believe the theory. But it is not certain that we shall do so, for not all ideas of true theories are asserted to be real. For example, I do not think that anyone, speaking carefully, would assert that the frequency of light is real; he would not say it was unreal; he would say that the conception of reality was inapplicable to a frequency, just as is the conception of triangularity. Personally, I should adopt that attitude towards the ideas of the theory of relativity; others might possibly differ.

But it must be noted that any influence the theory of relativity may have on our views of reality in this sense is shared by other theories. Prof. Carr is quite right when he suggests that the theory establishes some rather special relation between mathematics and physics; it gives reality, in the second sense, to ideas which derive their attractiveness, not from analogy with material laws, but from connection with mathematical form. But so does the Bohr-Sommerfeld

theory of the atom; the basis of the fundamental hypothesis $\int pdq = nh$ is purely mathematical, and cannot be stated apart from mathematical conceptions. So also, I think, does the Maxwellian theory of the electromagnetic field, but to discuss this matter would lead us too far. All that I am concerned to assert is that there is no sense of the word "real," relevant to experimental physics, in which the principle of relativity has a different kind of influence on our views of what is real from any other theory. In particular, it has no influence whatever on the belief that matter is real in any scientific sense. It may have some bearing on that doctrine in the metaphysical sense; but since, after considerable philosophic reading, I am still unable to discover what metaphysicians mean by "real," I clearly cannot discuss that question. But since, again, I can understand science without understanding metaphysics, I am naturally convinced that the two are completely independent.

NORMAN R. CAMPBELL.

DR. NORMAN CAMPBELL has not understood me. Probably thinking that I am an idealist philosopher, he has supposed that I must be arguing that there is no scientific reality in the accepted meaning—that is, no scientific criterion of reality—and that the naturalist's mongoose, for example, has just as much or just as little reality as the drunkard's. What I was pointing out was the fact that the principle of relativity *is* the rejection of materialism. Materialism is a causal theory of scientific reality. It is the argument that when we pronounce anything in our sense-experience to be real we imply an independent cause of it. According to the principle of relativity, the inference is entirely unnecessary and to insist on it unscientific. Instead of this causal theory relativity offers a simple correspondence theory. The Minkowski-Einstein universe consists of events co-ordinated by observers in their different systems of reference. What is essential to constitute the "real event" of any observer is that there should be point-to-point correspondence between his co-ordination of it and the different co-ordinations of other observers. The co-ordination of an event by any observer—that is, his perspective of the event—is not an effect which is the appearance to him of a "causal" reality, but an actual case in point of the reality itself. The "event" in the four-dimensional continuum, and its track the "world-line," in re-forming the notion of scientific reality has relegated scientific materialism to its right place in the limbo of scholasticism. Whatever his disagreement, at least Dr. Campbell need not be alarmed for the basis of scientific research.

November 9. H. WILDON CARR.

Hybridity and the Evolution of Species.

I AM sorry to say that the postscript of "The Writer of the Article" to my letter on p. 274 in NATURE of October 27 is not according to facts. It was he who used Trillium, Dirca, and Scoliopus as evidence against "bad pollen" being an indication of hybridity; this evidence appeared to me to be insufficient, and I stated the reason why. In his postscript "The Writer of the Article" makes no attempt to refute my arguments against his view, but says: "In such cases as Trillium, Dirca, and Scoliopus it is not sufficient for him [meaning me] to suggest that they must be hybrids merely because they have bad pollen," though I have never suggested this, or referred to Trillium, Dirca, and Scoliopus in any of my previous writings.

Perhaps I may be allowed to make use of this occasion to state my point of view shortly with regard to the question of bad pollen. I do not think that bad pollen is proof of a hybrid origin, but consider it as "suspect"; neither do I share Jeffrey's view that absence of bad pollen is a sign of a non-hybrid origin; as a fact, I know that it is not. Some of my segregates of the cross *Antirrhinum glutinosum* × *majus* have bad pollen, while others have not. I further think that "The Writer of the Article" is mistaken in his view that the theory of mutation *requires* the occurrence of a certain proportion of defective germ-cells. The facts are these:—When de Vries found bad pollen in *Oenothera Lamarckiana* he accounted for its presence on the *assumption* that this defect was caused by mutations; we now know that *O. Lamarckiana* is a hybrid, so that it is much more probable that hybridity is the cause of the presence of bad pollen; recent cytological work seems even to prove this.

May I beg zoologists to answer a question I should like to put to them, namely: Is there any evidence that the presence of oligopyrene and apyrene sperms in some insects and molluscs is due to hybridity?

I might finish my remarks here were it not that "The Writer of the Article" reproaches me with "begging the question" at issue. Nothing is farther removed from my intentions, so that I desire to deal shortly with all the points mentioned by him. He argues that it militates against the general applicability of the origin of species by hybridisation that not all British roses are hybrids. I fail to see the force of this argument, as it is well known that homozygotes can arise from a cross without showing any sign whatever of their hybrid origin; consequently, the fact of specific purity can never be used as an argument against a hybrid origin.

Nor does the fact that pollen sterility and fertility behave as a pair of characters in the sweet pea and the velvet bean tell against the origin of that bad pollen by hybridisation, as "The Writer of the Article" seems to think, unless he can bring forward arguments in favour of his contention which are unknown to me. Until then I must acknowledge I fail to see how behaviour of a character already existing can reveal its mode of origin; the idea that specific characters do not segregate while varietal characters do is, of course, obsolete.

"The Writer of the Article" finishes his remarks by pointing out that it will be necessary to bring some more convincing argument in support of hybridisation as a constructive evolutionary factor before it is likely to receive much serious consideration from biologists. If he means some more convincing argument than the suggested hybrid nature of Trillium, Dirca, and Scoliopus—a suggestion which is not mine—I cordially agree with him. I wonder whether the following will assist him in taking a kinder view of my theory than he evidently does?

It is a generally acknowledged fact that new breeds of animals and plants can arise by crossing, while no other mode of origin of them has ever been proved, although various other modes have been suggested. We all know that Darwin explained the origin of new forms in Nature largely on the mode of origin of domesticated races, so that it is of considerable importance to know the real nature of the "variations" among plants and animals under domestication which play so important a *rôle* in Darwin's writings.

Some time ago I happened to come across a letter of Darwin himself in his "Life and Letters," which seems to thrown important light on this momentous question. The letter is printed in full on p. 342 of the third volume of the "Life and Letters"; it was

addressed to Dr. J. H. Gilbert, and dated "Down, February 16, 1876." The following passage is the one which interests us here :—

"It is admitted by all naturalists that no problem is so perplexing as what causes every cultivated plant to vary, and no experiments as yet tried have thrown any light on the subject. Now for the last ten years I have been experimenting in crossing and self-fertilising plants; and one indirect result has surprised me much, namely, that by taking pains to cultivate plants in pots under glass during several successive generations, under nearly similar conditions, and by self-fertilising them in each generation the colour of the flower often changes, and, what is very remarkable, they became in some of the most variable species, such as Mimulus, Carnation, etc., quite constant, like those of a wild species."

We now know that the colour changes and the becoming constant to which Darwin refers were the results of the repeated self-fertilisation of heterozygous material, so that the supposed variability evidently was nothing but segregation after a cross.

Velp, Holland, November 2. J. P. LOTSY.

IT would take too much space to reply in detail to all of Dr. Lotsy's statements, for which I have great respect. They go far outside the original point at issue, but it is necessary to refer to the more important of them, and it will then probably be seen that the others are immaterial. In his original letter (NATURE, October 27, p. 274), which commented on an article of mine on "British Roses and Hybridity" (NATURE, September 15, p. 99), he states that Jeffrey's work tends "to show that the presence of 'bad pollen' is *proof* [my italics] of a hybrid origin," and goes on to say that this view is "much strengthened" by other work. He correctly states that I took exception to that view, my own view being that "bad pollen" is unsafe as a criterion of hybridity, in support of which I cited various facts. As some of these facts were from a paper of which I was joint author, the original article was unsigned, but since this controversy, which was not of my seeking, has arisen, I prefer to sign my own name. In his present letter Dr. Lotsy seems to forget that the burden of proof rests upon those who assume that bad pollen is a proof of hybridity. He says that my postscript to his article is "not according to facts," and that he did not suggest the hybrid nature of Trillium, Circa, and Scoliopus. I can only ask, if that is the case, why did he refer to them in his original article? Cytological work, which is by no means all "recent," proves that hybridity is *a* cause of bad pollen, but by no means proves that it is the only cause.

Dr. Lotsy has apparently omitted a consideration of lethal factors from his views. This is a more recent discovery which is of much significance in the interpretation of sterility, not only in Drosophila, but in various Œnothera forms, and it may apply either to gametes or zygotes. The conception has already been fruitfully applied, not only to various plants and animals, but also to man himself. When I said that the theory of mutation requires the occurrence of a certain proportion of defective germ-cells I had similar cases in mind, and did not mean to imply that mutations were necessarily *always* accompanied by germ-cell sterility. But clearly, if lethal factors account for germ-cell sterility in some cases, it is inadmissible to assume that bad pollen is in itself a proof of hybridity. We must apply the conception of multiple causes.

It follows that in any given case, such as that of *Oenothera Lamarckiana*, bad pollen *may* have originated from crossing, from lethal factors, or from some other cause, unless one or more of these possible causes can be eliminated. Dr. Lotsy says, "We now know that *O. Lamarckiana* is a hybrid." One can only ask how we know, and in what sense he is using the term hybrid. So far as the theory of mutation in Œnothera is concerned, it no longer matters whether *O. Lamarckiana* is a garden hybrid or not, since the work of Bartlett has proved that various close-pollinated wild American species of Œnothera show the same mutation behaviour.

Finally, I would say that if by his theory of evolution by hybridisation Dr. Lotsy means merely that the intercrossing of related races is the condition in which evolution has frequently taken place, I, for one, would heartily agree with him. For I have long advocated the view that among open-pollinated plants and most animals the evolutionary unit is an interbreeding population of closely related forms. I fancy many biologists adhere to a similar point of view. But I take it that Dr. Lotsy means much more than that by his theory, and if I understand him correctly, that is his reason for tacitly denying the existence of germinal changes. One can only ask how two visibly similar homozygous organisms when crossed can give rise to new germinal characters if they have not during the previous period of their isolation undergone germinal changes. R. RUGGLES GATES.

King's College, Strand, November 11.

Biological Terminology.

(*a*) "VARIATION is the sole cause of non-inheritance"; (*b*) "Apart from variations like exactly begets like, when parent and child develop under like conditions"; (*c*) "The development of the individual is a recapitulation (with additions and subtractions due to variations) of the evolution of the race." Here are three statements which seem to me "*in effect*" identical. To Dr. Bather the first two seem identical, but not the third. But if the child in his own development step by step recapitulates (with variations) the development of the parent, and the parent in the same way recapitulated that of the grandparent, and so on to the beginning, how, in the world, can the development of the individual be anything other than a recapitulation (with the accumulated variations) of the evolution of the race? If that be so, does not (*b*) necessarily involve (*c*)? (*c*) is merely (*b*) applied to a succession of parents and children. Dr. Bather says (NATURE, October 27, p. 271) that this is not what biologists mean. Then what do they mean? "Recapitulation" must be one of those terrible words which, like "inherit," are used, quite unconsciously, with a number of diverse and even contradictory meanings.

It is pleasant to find that Dr. Bather approves of Prof. Goodrich's address, for probably it has set the heather alight at last. In my humble way I also am enormously pleased. Still, Dr. Bather should bear in mind the history of this matter, some of which Prof. Goodrich indicates. As long ago as the 'eighties Weismann declared that "an organism cannot acquire anything unless it already possesses the predisposition to acquire it." At that time, too, doctors were beginning to insist that not actual diseases, but only predispositions to acquire them, were inheritable. Weismann failed to perceive the necessary consequences of his own idea—predisposition is all that can be inherited in the case of any character; all characters, therefore, are equally and in exactly the same sense innate, acquired, and inheritable. Instead he assumed, with Lamarck, that some characters are innate and others acquired, and so started the famous—or infamous—Lamarckian controversy. Sandeman did, however, very definitely

follow out the idea in 1896, as did Adam Sedgwick in 1899. If authority be necessary, here is authority in plenty. I also tried in my very humble way, beginning as long ago as 1906. I daresay each man in turn thought he was propounding something new. Dr. Cunningham perceives, I hope, that Prof. Goodrich is spared the disgrace of being my pupil, and that even the most self-respecting biologist may, in this instance, follow the truth without qualms of conscience. Dr. Bather knows with what reception I met. I was told that I was doing harm, that biologists could manage their affairs quite well without my help, and so forth. Then the worm turned. So far as I am able to judge, Dr. Bather objects to my letters because they are tediously long and because they are impudent. Certainly they are long, and doubtless they are tedious. But I could state, or assume, in half a dozen words a fallacy which Dr. Bather could not refute in less than half a dozen columns. Moreover, as Dr. Bather courteously indicates, it has been holiday time, during which one does unusual things; therefore I have used his letters —with all reverence, as a parson might—as texts whereon to hang admonitory discourses. Certainly these letters have been impudent—most impudent. But here, again, we have the trodden worm.

Dr. Bather thinks I ought not to discuss variations unless I first account for them, which is like saying I ought not to eat my dinner unless I first cook it. Must I not accept the given fact? I am at once accused of being tediously long and not long enough. What is a poor man to do? Besides, I have tried elsewhere ("The Laws of Heredity," chap. 5) to do this very thing. Primarily variations can arise only in two ways. Either they are impressed on the germ-plasm by its environment, or they occur because the germ-plasm is a living, growing, changing thing which, like other living things, tends to revert to the normal from impressed change, especially injury. There exists ample crucial evidence to enable us to reach a decision, but much of it lies, outside the high roads followed by biologists, in the realms of disease and bacteriology.

Dr. Cunningham's letter (NATURE, November 17, p. 368) is addressed especially to Prof. Goodrich, who may deal with it if he desires; but one passage refers to my particular hobby. Lamarck called the changes which result from use "acquired"; but, thinking only of trifling changes which occur at the end of the development, he did not realise that the growth of the higher animals, especially man, is due mainly to that functional activity which begins to act immediately after birth. His successors employed the word "acquired" as indicating any character which develops under any very glaring influence. Now Dr. Cunningham defines an acquired character as a "change" (from the person's antecedent self, from the parent, from the race—which?) due to "environment or modification." In that case the English language is not "acquired," but is "innate" in an Englishman. If learned by a Frenchman, it is acquired. Heaven knows what it is if learned in Jersey. He accuses Prof. Goodrich and me of a "misuse of words" and of obscuring "a *perfectly clear* distinction"! The italics are mine!

G. ARCHDALL REID.

9 Victoria Road, Southsea, November 19.

The Softening of Secondary X-rays.

DR. A. H. COMPTON in a letter on this subject in NATURE of November 17, p. 366, described an experiment in which he reflected the Kα rays from a molybdenum Coolidge tube on to a slab of paraffin, and measured the absorption coefficient of the secondary scattered rays at different angles with respect to the direction of the primary beam. The absorption coefficient of the secondary rays was found to be 29 per cent. greater than that of the primary Kα beam at $\theta=90°$, and 6 per cent. greater at $\theta=20°$. This softening of the rays on being scattered was still more pronounced when the K lines of tungsten were used.

Dr. Compton referred to this work as a repetition of measurements which I had previously reported (*Phil. Mag.*, September, 1921), in which no such increase in absorption after scattering was observed, and he attributed my negative result to an unfavourable choice of wave-length and angle. Apparently he did not understand the purpose of my experiment. It was to settle a question regarding the interpretation of energy measurements made with the Bragg spectrometer. We were not sure that the atom in a scattering substance does not always absorb energy from the incident rays and re-emit this energy in a manner characteristic of the atom and independent of θ. My problem was to find out if such an effect need be considered in ordinary spectrometer measurements. The wave theory of scattering predicts a certain amount of softening due to the finite size of the atom and to a sort of Doppler effect, but not nearly the observed amount, especially at large angles.

As Dr. Compton suggests, there is probably an additional somewhat softer radiation due to collisions of electrons released within the scattering substance by the primary rays. Such a "fluorescent" radiation should diminish with θ, as observed. The softening due to the finite size of the atom should also, in general, diminish with θ and be negligible in the characteristic radiation, which is believed to consist of relatively sustained wave-trains. Softening due to these recognised causes can thus be minimised by using the sustained characteristic rays, large wave-lengths, and θ as small as possible. I chose these conditions, which were unfavourable to the Compton effect, because I wanted to eliminate it so far as possible. The negative result simply indicates that with light atoms the indirect unpolarised radiation sought is not great enough to require consideration in ordinary crystal measurements.

S. J. PLIMPTON.

Worcester Polytechnic Institute, Worcester, Massachusetts, November 8.

The Molecular Scattering of Light in Liquids and Solids.

As was pointed out by the late Lord Rayleigh, the basis of his theory of the blue sky, namely, that the molecules scatter the incident energy independently of each other's presence, is only true for gases in consequence of the freedom of movement the molecules possess in this state of matter. In connection with the problem of the colour of the sea and of deep waters generally it is necessary to know the scattering power of ordinary liquids, such as water, and I find this can be very simply accomplished by application of the theory of local fluctuations of density arising from molecular movement, originated by Einstein and Smoluchowski and utilised by the latter to elucidate the phenomena occurring near the critical state. The general formula for the scattering power of a fluid is

$$\frac{\pi^2}{18}\frac{RT\beta}{N\lambda^4}\left(\mu^2-1\right)^2\left(\mu^2+2\right)^2,$$

where β is the compressibility of the substance, μ its refractive index, R, T, N being the usual constants of the kinetic theory. The scattering power of water comes out from this formula as about 160 times that

of air. Not only is this in agreement with observation, but I find the coefficient of extinction of light due to scattering

$$\frac{8\pi^3}{27}\frac{RT\beta}{N\lambda^4}\left(\mu^2-1\right)^2\left(\mu^2+2\right)^2$$

closely represents the observed transparency of pure water in the region of the spectrum where there is no selective absorption. Work is now in progress testing the formula in the case of other liquids.

It is clear that an application of the same idea of local fluctuations of optical density and of Debye's theory of the thermal movements in solids would give the theoretical scattering power of transparent crystals for ordinary light. This is also being tested.

C. V. RAMAN.

210 Bowbazaar Street, Calcutta, October 15.

The Tendency of Elongated Bodies to Set in the North and South Direction.

THE letter from Sir Arthur Schuster in NATURE of October 20 last requires amplification and amendment in one particular. The setting tendency of an elongated body depends upon its method of support. If suspended, with the centre of gravity not free to rise and fall, it is at its "lowest" position when lying on the equipotential section of maximum radius of curvature, *i.e.* tends to set east and west. A floating body, on the other hand, where the centre of gravity is free to rise and fall, is at its lowest when lying on the equipotential of minimum radius of curvature, *i.e.* north and south. The whole matter is fully discussed in an article by Mr. W. D. Lambert, of the United States Coast and Geodetic Survey in the *American Journal of Science* for September last.

The tendency of the rod of a torsion balance to set east and west was pointed out by Baron Eötvös in one of his early papers, probably one of those presented to the International Geodetic Conference, but I am not able to lay my hands on the exact reference.

E. H. GROVE-HILLS.

Ophion luteus.

IT is a quite common experience to see *Ophion luteus* fly into houses at night attracted by light. I have myself captured at least half a dozen specimens that had in a single hour flown into a room in that way. Not long ago Dr. James Waterston, at my request, dissected a fresh female specimen, and found in it a poison gland, reservoir, and duct similar in character to those recorded as being present in certain other species of Ichneumonidæ.

M. R. du Buysson, in a paper (*Rev. d'Entomologie*, vol. 11, p. 257, 1892) which I have only recently seen, states that he had often been stung by Ichneumonidæ of the Ichneumon, Pimpla, and Ophion groups; but however much poison may have been injected, the pain and inflammation produced by the sting, he says, lasted only a short time. He dissected a large number of specimens belonging to all the groups of Ichneumonidæ, and always found one or several poison glands present.

The larvæ of *Ophion luteus* appear to be parasitic in the caterpillars of many different species of Lepidoptera; but it would appear to be the case also that the female does not pierce the skin of the caterpillar to lay her eggs inside. She is said to lay them on the skin. That point probably needs confirmation. But however that may be, it seems to me incredible that the female would mistake the arm of a young lady for a caterpillar. In M. du Buysson's case, the insect had always been held in the hand or otherwise irritated before it attempted to sting, and this seems to be the general experience. He was never puzzled to divine the purpose of the sting, regarding it, no doubt, simply as an act of self-defence; and that is the explanation which I would venture to suggest in reply to Sir Herbert Maxwell's letter in NATURE of November 10.

C. J. GAHAN.

Natural History Museum, S.W.7, November 14.

IN respect of Sir Herbert Maxwell's letter in NATURE of November 10 on *Ophion luteus*, Linn., may we hope that the insect caught *flagrante delicto* was preserved in order that the species might be placed beyond a doubt, these large red Ophionidæ being almost impossible to differentiate at a glance?

Ophion luteus is apparently a nocturnal insect. I have observed it at night hunting for Dianthœcia larvæ. The species is credited with a long list of hosts, chiefly Noctuid moth caterpillars.

Almost all Ichneumonidæ will "sting" or attempt to if handled, the males included (though, of course, morphologically incapable), but that any member should make an attack unprovoked is most unusual. *O. luteus* and allied species are extremely bad-tempered—a fact which hampers work with them in confinement, as they repeatedly "sting" potential hosts to death without attempting to parasitise them. Perhaps this irritability was the cause of the unusual attack.

R. STENTON.

Pathological Laboratory, Ministry of Agriculture, Harpenden, November 19.

Sex-manifestation and Motion in Molluscs.

I DO not wish to prolong the discussion upon sex-differentiation and mode of life, though I venture to think that Dr. Orton's reply in NATURE of November 3 to my letter in the issue of October 13 leaves several questions very much as they were before.

On many points I find myself in agreement with Dr. Orton, though I consider that the incidence of sex-differentiation in the Mollusca does not exhibit that general correlation with an active habit demanded by Dr. Orton's hypothesis. I quite agree, as I said in my previous letter, that many forms originally considered diœcious *may* be monœcious; but I think it is for Dr. Orton to prove this, and I shall await his demonstration with interest. I would like to point out, however, that it will not be enough to show *sex-change* (a turnover from maleness to femaleness, or *vice versa*). The implications of Dr. Orton's hypothesis entitle me to demand from him something in the nature of *permanent* hermaphrodite forms.

G. C. ROBSON.

Natural History Museum, S.W.7, November 14.

Sinistral Limnaea peregra.

LAST year I started a breeding experiment with two pairs of sinistral *Limnaea peregra* given me by Mr. J. W. Taylor, of Leeds. The first two generations have not come out on any plain plan, and it is necessary to carry them further if the mode of inheritance of this very rare form of one of our commonest freshwater snails is to be worked out. But the young have now quite outgrown the possibilities of my establishment, and if anyone would take over some of them and breed them out (which is quite simple, as they want little attention) they would be doing me a service.

A. E. BOYCOTT.

University College Hospital Medical School, University Street, Gower Street, W.C.1, November 7.

Some Problems in Evolution.[1]

By PROF. EDWIN S. GOODRICH, F.R.S.

IT was nearly one hundred years ago that Charles Darwin began his scientific studies in the University of Edinburgh. No more fitting subject, I think, could be found for an address than certain problems relating to his doctrine of evolution. Perhaps the best way of treating these general subjects is by trying to answer some definite questions. For instance, we may ask: "Why are some characters inherited and others not?" By characters we mean all those qualities and properties possessed by the organism, and by the enumeration of which we describe it: its weight, size, shape, colour, its structure, composition, and activities. Next, what do we mean by "inherited"? It is most important, if possible, clearly to define this term, since much of the controversy in writings on evolution is due to its use by various authors with a very different significance—sometimes as mere reappearance, at other times as actual transmission or transference from one generation to the next. Now, I propose to use the word inheritance merely to signify the reappearance in the offspring of a character possessed by the ancestor—a fact which may be observed and described, regardless of any theory as to its cause. Our question, then, is: "Why do some characters reappear in the offspring and others not?"

It is sometimes asserted that old-established characters are inherited, and that newly-begotten ones are not, or are less constant, in their reappearance. This statement will not bear critical examination. For, on one hand, it has been conclusively shown by experimental breeding that the newest characters may be inherited as constantly as the most ancient, provided they are possessed by both parents.[2] While, on the other hand, few characters in plants can be older than the green colour due to chlorophyll, yet it is sufficient to cut off the light from a germinating seed for the greenness to fail to appear. Again, ever since Devonian times vertebrates have inherited paired eyes; yet, as Prof. Stockard has shown, if a little magnesium chloride is added to the sea-water in which the eggs of the fish Fundulus are developing, they will give rise to embryos with one median Cyclopean eye! Nor is the suggestion any happier that the, so to speak, more deep-seated and fundamental characters are more constantly inherited than the trivial or superficial. A glance at organisms around us, or the slightest experimental trial, soon convinces us that the apparently least-important character may reappear as constantly as the most fundamental. But while an organism may live without some trivial character, it can rarely do so when a fundamental character is absent, hence such incomplete individuals are seldom met in Nature.

Yet undoubtedly some characters reappear without fail and others do not. If it is neither age nor importance, what is it that determines their inheritance? The answer is that for a character to reappear in the offspring it is essential that the germinal factors and the environmental conditions which co-operated in its formation in the ancestor should both be present. Inheritance depends on this condition being fulfilled. For all characters are of the nature of responses to environment[3]; they are the products or results of the interaction between the factors of inheritance (germinal factors) and the surrounding conditions or stimuli. This power of response or reaction is no mysterious property of organisms—it is the effect produced, the disturbance brought about by the application of a stimulus. All the special properties and activities of living organisms utimately depend on their metabolism, of which growth and reproduction are the chief manifestations. The course of metabolism, and, consequently, the development in the individual of a character, is moulded or conditioned by the environmental stimuli under which it takes place. On the other hand, the living substance, protoplasm, which is undergoing metabolism is the material basis of the organism. It has a specific composition and structure peculiar to the particular kind of organism concerned, and this is handed on to the offspring in the germ-cells from which starts the new generation. The inheritance of a character is due, then, not only to the actual transmission or transference of this specific "germ-plasm" containing the same factors of inheritance (germinal factors) as those from which the parent developed, but also to this factorial complex developing under the same conditions (environmental stimuli), as those under which the parent developed. Any alteration either in the effective environmental stimuli or in the germinal factors will produce a new result, will give rise to a new character, will cause the old character to appear no longer.

Now what is actually transmitted from one generation to the next is the complex of germinal factors. Hence we should carefully distinguish between transmission and inheritance. Much of the endless confusion and interminable controversies about the inheritance of so-called "acquired characters" is due to the neglect of this important distinction. For it is quite clear that whereas factors may be transmitted, characters as such never are. The characters of the adult, being responses, are not present as such

[1] Abridged from the presidential address delivered to Section D (Zoology) of the British Association at Edinburgh on September 8.

[2] We purposely set aside complications due to hybridisation and Mendelian segregation, which do not directly bear on the questions at issue.

[3] In a letter to NATURE Sir Ray Lankester long ago directed attention to the importance of this consideration when discussing inheritance. He also pointed out that Lamarck's first law, that a new stimulus alters the characters of an organism, contradicts his second law, that the effects of previous stimuli are fixed by inheritance. (NATURE, vol. 51, 1894.)

in the fertilised ovum from which it develops, they are produced anew at every generation.[4] No distinction in kind or value can be drawn between characters.

If some are inherited regularly and others are not, the distinction lies not in the nature or mode of production of the characters themselves, but in the constancy of the factors and conditions which give rise to them. Thus, although there is only one kind of character, there are two kinds of variation.

Much of the confusion in evolutionary literature is, I think, due to the use of the word variation in a loose manner. Sometimes it is taken to mean the degree of divergence between two individuals; sometimes the character itself in which they differ, such as a colour or spot on a butterfly's wing; at other times a variety or race differing from the normal form of the species. If clearness of thought and expression is to be attained, the word variation should mean the extent or degree of difference between two individuals or between an individual and the average of the species, the divergence of the new form from the old; not a new character or assemblage of characters, but a difference which can be measured or at least estimated. We shall then find that a variation is of one of two kinds (which may, of course, be combined): the first kind is due to some change in the complex of effective environmental stimuli, the second to some change in the complex of germinal factors.

The second kind, to which the name mutation has been applied, will, under constant conditions, be inherited since the new complex of factors will be transmitted to subsequent generations. The first kind of variation, which has been called a modification, will also be inherited, provided, of course, the change of stimulus persists. In either case, new characters will result. But here, again, we must be careful not to apply the terms mutation and modification to the characters themselves, as is so often done[5]; for we then reintroduce the confusion already exposed in the popular but misleading distinction between "acquired" and "non-acquired" characters. The characters due to mutation or modification are, of course, indistinguishable by mere inspection, and can only be separated by experiment. A mutation once established should give rise, under uniform conditions, to a new heritable character, and may be detected by crossing with normal members of the species.

So far observations and tests have shown that new characters due to modification only reappear so long as the new stimulus persists. The difference lies not in the value or permanence of the new character, but in the causes which give rise to it.[6]

It is little more than a platitude to state that for the production of an organism or of any of its characters both germinal factors and environmental stimuli are necessary, and that if evolution is to take place there must be change in one or both. Yet the changes in the factors may be held to be the more important. In an environment which on the whole alters but little, evolution progresses by the cumulation along diverging lines of adaptation of new characters due to mutation. Thus natural selection indirectly preserves those factorial complexes which respond in a favourable manner. In other words, an organism, to survive in the struggle for existence, must present that assemblage of factors of inheritance which, under the existing environmental conditions, will give rise to advantageous characters.

In answer to a further question, let us now try to explain what we mean when we contrast the organism with its environment. In its simplest and most abstract form a living organism may be likened to a vortex. That mixture of highly complex proteins we call protoplasm, the physical basis of life, is perpetually undergoing transformations of matter and energy, so long as life persists. Towards the centre of the vortex the highest compounds are continually being built up and continually being broken down; new material (food, water, oxygen) and energy are brought in at the periphery, and old material and energy (work and heat) thrown out. The principle of the conservation of energy and matter holds good in organised living processes as it does in the inorganic world outside. This is the process we call metabolism, and it is at the base of all the manifestations of life. From the point of view of biological science life is founded on a complex and continuous physico-chemical process of endless duration so long as conditions are favourable; just as a fire will continue to burn so long as fuel is at hand. No one step, no single substance, can be said to be living: the whole chain of substances and reactions, every link of which is essential, constitutes the life-process. A stream of non-living matter with stored-up energy is built up into the living vortex, and again passes out as dead matter, having yielded up the energy necessary for the performance of the various activities of the organism. If more is taken in than is given out it will grow and sub-divide. The complexity of the organism may increase by the formation of subsidiary, more or less interdependent, vortices within it. The perpetual growth and transmission of factors of inheritance, the continuity of the germ-plasm, is but another aspect of the continuity of the metabolic process forming the basis of the continuity of life in evolution.

But all environmental stimuli are not external

[4] In other words, all characters are "acquired during the lifetime of the individual," and "inherited" in the sense here defined has just the same meaning. Much the same view was advocated by Prof. A. Sedgwick in his address to this Section at Dover in 1899, and it has also been developed by Sir Archdall Reid and others.

[5] The name "mutation" might be given to the alteration in the factors instead of the variation due to it. The latter might then be termed a mutational variation and would be opposed to a modificational variation. At present the term "mutation" is applied to three different things: the actorial change, the variation or difference, and the new product, response for character.

[6] We might perhaps distinguish the two cases by calling them constant and inconstant characters, or "natural" and "acquired," as is commonly done when describing immunity. It should be meant thereby that one is acquired usually (under normal conditions), the other occasionally (when infection occurs). Error creeps in when the term "acquired" is opposed to "non-acquired" or to "inherited."

to the organism. Just as the various steps in the metabolic process are dependent on those which preceded them, so when an organism becomes differentiated into parts, when the main process becomes sub-divided into subsidiary ones, these react on each other. What is internal to the whole becomes external to the part. An external stimulus may set up an internal metabolic change, giving rise to a response the extent and nature of which depend on the structure of the mechanism and its state when stimulated, that is to say, on the effect of previous responses. Such a response may act as an internal stimulus giving rise to a further response, which may modify the first, and so on. Parts thus become marvellously fitted to set going, inhibit, or regulate each other's action; and thus arises that power of individual adaptation, or self-regulation, so characteristic of living organisms. The processes of temperature regulation, of respiration, of excretion are examples of such delicate self-regulating mechanisms in ourselves. But one of the great advantages thereby gained by organisms is that they can regulate their own growth and ensure their own "right" development. Whereas the simplest plants and animals are to a great extent, so to speak, at the mercy of their external environment, except in so far as they can move from unfavourable to more favourable surroundings; whereas their characters appear in response to external stimuli which may or may not be present, and over which they have little or no control—the higher organisms (more especially the higher animals), as it were, gradually substitute internal for external stimuli. Food material is provided in the ovum, and the size, structure, and time of appearance of various characters are regulated to a great extent by use and by the secretions of various endocrinal glands, the action of which has been so successfully studied, among others, by Sir E. Sharpey Schafer in this university. Thus, as is well shown in man, the higher animals acquire considerable independence, and are little affected in their development by minor changes of environment. Inheritance is thus made secure by ensuring that the necessary conditions are always present.

We may seem to have wandered far from our original question; but the answer now appears to be that only those characters can be regularly inherited which depend for their appearance on conditions always fulfilled in the normal environment (external or internal); and those characters will not be regularly inherited which depend on stimuli that may or may not be present.

Now it will be said, and not without some truth, that all this is mere commonplace admitted by all; but, if so, it is, I think, often ignored or misunderstood in discussions on heredity, more especially in semi-popular writings, and sometimes even in scientific works. However, I quite willingly admit that the real problems Darwin left to be solved by the evolutionist are the nature of the germinal factors themselves, and more especially the origin of the differences between them, the origin of those changes which give rise to mutations.

That these factors[7] must at least be self-propagating substances, subsidiary vortices in the main stream of metabolising living protoplasm, is certain, since they grow and multiply repeatedly, to be distributed to new generations of germ-cells. That they may be relatively constant and remain unaltered for generations seems also certain, since organisms or their parts can continue almost unchanged for untold ages. That they can act independently, can be separately distributed into different germ-cells, and can be re-combined seems likewise to have been proved by the brilliant work of Mendel and his followers. So independent and constant do they appear to be that modern students of heredity tend to treat them as so many beads in a row, as separate particles themselves endowed with all the properties of independent living organisms, the very properties we wish to explain. While not prepared to accept these views without qualification, it seems to me that it can scarcely be doubted that some such units must exist whether in the form of discrete particles or merely of separable substances. But not until these factors have been brought into relation with the general metabolism of the organism, as links in the chain of processes, will the problem of inheritance approach solution. If the theory is to be completed it must attempt to explain how they come to differ, how their orderly behaviour is regulated, in what functional relation they stand to each other, what is the metabolic bond between them. That harmonious processes may be carried out by discrete elements in co-operation is shown in cases of symbiotic combinations such as the lichens, or the green algæ in such animals as Hydra and Convoluta. Here an originally independent organism takes its place and does its work regularly in another organism, and may even be propagated and transmitted from one generation to the next in the germ-cell! Most instructive, also, are the recently studied cases of bacteria and yeasts living regularly in certain special tissues of various species of insects, where they exert a definite influence on the metabolism (see the works of Pierantoni, Buchner, Glaser). These no doubt are mere analogies, but they serve.

In all probability, then, factors of inheritance exist, and the fundamental problem of biology is how are the factors of an organism changed, or how does it acquire new factors? In spite of its vast importance, it must be confessed that little advance has been made towards the solution of this problem since the time of Darwin, who considered that variation must ultimately be due to the action of the environment. This conclusion is inevitable, since any closed system will reach

[7] Herbert Spencer's "physiological units," Darwin's "pangens," Weismann's "determinants," are all terms denoting factors, but with somewhat different meanings. More recently Prof. W. Johannsen ("Elemente der exakten Erblichkeitslehre," 1909) has proposed the term "gene" for a factor, "genotype" for the whole assemblage of factors transmitted by a species, and "phenotype" for the characters developed from them. This clear system of nomenclature, although much used in America, has not been generally adopted in this country.

a state of equilibrium and continue unchanged, unless affected from without. To say that mutations are due to the mixture or re-shuffling of pre-existing factors is merely to push the problem a step farther back, for we must still account for their origin and diversity. The same objection applies to the suggestion that the complex of factors alters by the loss of certain of them. To account for the progressive change in the course of evolution of the factors of inheritance and for the building up of the complex it must be supposed that from time to time new factors have been added; it must further be supposed that new substances have entered into the cycle of metabolism, and have been permanently incorporated as self-propagating ingredients entering into lasting relation with pre-existing factors. We are well aware that living protoplasm contains molecules of large size and extraordinary complexity, and that it may be urged that by their combination in different ways, or by the mere regrouping of the atoms within them, an almost infinite number of changes may result, more than sufficient to account for the mutations which appear. But this does not account for the building up of the original complex. If it must be admitted that such a building process once occurred, what right have we to suppose that it ceased at a certain period? We are driven, then, to the conclusion that in the course of evolution new material has been swept from the banks into the stream of germ-plasm.

Let it not be thought for a moment that the admission that factors are alterable opens the door to a Lamarckian interpretation of evolution! According to the Lamarckian doctrine, at all events in its modern form, a character would be inherited after the removal of the stimulus which called it forth in the parent. Now of course, a response once made, a character once formed, may persist for longer or shorter time according as it is stable or not; but that it should continue to be produced when the conditions necessary for its production are no longer present is unthinkable. It may, however, be said that this is to misrepresent the doctrine, and that what is really meant is that the response may so react on and alter the factor as to render it capable of producing the new character under the old conditions. But is this interpretation any more credible than the first?

Let us return to the possible alteration of factors by the environment. Unfortunately there is little evidence as yet on this point. In the course of breeding experiments the occurrence of mutations has repeatedly been observed, but what led to their appearance seems never to have been so clearly established as to satisfy exacting critics. Quite lately, however, Prof. M. F. Guyer, of Wisconsin, has brought forward a most interesting case of the apparent alteration at will of a factor or set of factors under definite well-controlled conditions.[8] You will remember that if a tissue substance, blood-serum for instance, of one animal be injected into the circulation of another, this second individual will tend to react by producing an anti-body in its blood to antagonise or neutralise the effect of the foreign serum. Now Prof. Guyer's ingenious experiments and results may be briefly summarised as follows. By repeatedly injecting a fowl with the substance of the lens of the eye of a rabbit he obtained anti-lens serum. On injecting this "sensitised" serum into a pregnant female rabbit it was found that, while the mother's eyes remained apparently unaffected, some of her offspring developed defective lenses. The defects varied from a slight abnormality to almost complete disappearance. No defects appeared in untreated controls; no defects appeared with non-sensitised sera. On breeding the defective offspring for many generations these defects were found to be inherited, even to tend to increase and to appear more often. When a defective rabbit is crossed with a normal one the defect seems to behave as a Mendelian recessive character, the first generation having normal eyes and the defect reappearing in the second. Further, Prof. Guyer claims to have shown that the defect may be inherited through the male as well as the female parent, and is not due to the direct transmission of anti-lens from mother to embryo *in utero*.

If these remarkable results are verified, it is clear that an environmental stimulus, the anti-lens substance, will have been proved to affect not only the development of the lens in the embryo, but also the corresponding factors in the germ cells of that embryo; and that it causes, by originating some destructive process, a lasting transmissible effect giving rise to a heritable mutation.

Prof. Guyer, however, goes farther, and argues that, since a rabbit can also produce anti-lens when injected with lens substance, and since individual animals can even produce anti-bodies when treated with their own tissues, therefore the products of the tissues of an individual may permanently affect the factors carried by its own germ-cells. Moreover he asks, pointing to the well-known stimulative action of internal secretions (hormones and the like), if destructive bodies can be produced, why not constructive bodies also? And so he would have us adopt a sort of modern version of Darwin's theory of pangenesis, and a Lamarckian view of evolutionary change.

But surely there is a wide difference between such a poisonous or destructive action as he describes and any constructive process. The latter must entail, as I tried to show above, the drawing of new substances into the metabolic vortex. Internal secretions are themselves but characters, products (perhaps of the nature of ferments) behaving as environmental conditions, not as self-propagating factors, moulding the responses, but not permanently altering the fundamental structure and composition of the factors of inheritance.

[8] *American Naturalist*, vol. 55, 1921; *Jour. of Exper. Zoology*, vol. 31, 1920.

Moreover, the early fossil vertebrates had, in fact, lenses neither larger nor smaller on the average than those of the present day. If destructive anti-lens had been continually produced and had acted, its effect would have been cumulative. A constructive substance must, then, have also been continually produced to counteract it. Such a theory might perhaps be defended; but would it bring us any nearer to the solution of the problem?

The real weakness of the theory is that it does not escape from the fundamental objections we have already put forward as fatal to Lamarckism. If an effect has been produced, either the supposed constructive substance was present from the first, as an ordinary internal environmental condition necessary for the normal development of the character, or it must have been introduced from without by the application of a new stimulus. The same objection does not apply to the destructive effect. No one doubts that if a factor could be destroyed by a hot needle or picked out with fine forceps the effects of the operation would persist throughout subsequent generations. Nevertheless, these results are of the greatest interest and importance.

There remains another question we must try to answer before we close, namely, "What share has the mind taken in evolution?" From the point of view of the biologist, describing and generalising on what he can observe, evolution may be represented as a series of metabolic changes in living matter moulded by the environment. It will naturally be objected that such a description of life and its manifestations as a physico-chemical mechanism takes no account of mind. Surely, it will be said, mind must have affected the course of evolution, and may indeed be considered as the most important factor in the process. Now, without in the least wishing to deny the importance of the mind, I would maintain that there is no justification for the belief that it has acted or could act as something guiding or interfering with the course of metabolism. This is not the place to enter into a philosophical discussion on the ultimate nature of our experience and its contents, nor would I be competent to do so; nevertheless, a scientific explanation of evolution cannot ignore the problem of mind if it is to satisfy the average man.

Let me put the matter as briefly as possible at the risk of seeming somewhat dogmatic. It will be admitted that all the manifestations of living organisms depend, as mentioned above, on series of physico-chemical changes continuing without break, each step determining that which follows; also that the so-called general laws of physics and of chemistry hold good in living processes. Since, so far as living processes are known and understood, they can be fully explained in accordance with these laws, there is no need and no justification for calling in the help of any special vital force or other directive influence to account for them. Such crude vitalistic theories are now discredited, but tend to return in a more subtle form as the doctrine of the interaction of body and mind, of the influence of the mind on the activities of the body. But, try as we may, we cannot conceive how a physical process can be interrupted or supplemented by non-physical agencies. Rather do we believe that to the continuous physico-chemical series of events there corresponds a continuous series of mental events inevitably connected with it; that the two series are but partial views or abstractions, two aspects of some more complete whole, the one seen from without, the other from within, the one observed, the other felt. One is capable of being described in scientific language as a consistent series of events in an outside world, the other is ascertained by introspection, and is describable as a series of mental events in psychical terms. There is no possibility of the one affecting or controlling the other, since they are not independent of each other. Indissolubly connected, any change in the one is necessarily accompanied by a corresponding change in the other. The mind is not a product of metabolism as materialism would imply, still less an epiphenomenon or meaningless by-product as some have held. I am well aware that the view just put forward is rejected by many philosophers, nevertheless it seems to me to be the best and indeed the only working hypothesis the biologist can use in the present state of knowledge. The student of biology, however, is not concerned with the building up of systems of philosophy, though he should realise that the mental series of events lies outside the sphere of natural science.

The question, then, which is the more important in evolution, the mental or the physical series, has no meaning, since one cannot happen without the other. The two have evolved together *pari passu*. We know of no mind apart from body, and have no right to assume that metabolic processes can occur without corresponding mental processes, however simple they may be.

Simple response to stimulus is the basis of all behaviour. Responses may be linked together in chains, each acting as a stimulus to start the next; they can be modified by other simultaneous responses, or by the effects left behind by previous responses, and so may be built up into the most complicated behaviour. But, owing to our very incomplete knowledge of the physico-chemical events concerned, we constantly, when describing the behaviour of living organisms, pass, so to speak, from the physical to the mental series, filling up the gaps in our knowledge of the one from the other. We thus complete our description of behaviour in terms of mental processes we know only in ourselves (such as feeling, emotion, will) but infer from external evidence to take place in other animals.

In describing a simple reflex action, for instance, the physico-chemical chain of events may appear to be so completely known that the corresponding mental events are usually not mentioned

at all, their existence may even be denied. On the contrary, when describing complex behaviour when impulses from external or internal stimuli modify each other before the final result is translated into action, it is the intervening physico-chemical processes which are unknown and perhaps ignored, and the action is said to be voluntary or prompted by emotion or the will.

The point I wish to make, however, is that the actions and behaviour of organisms are responses, are characters in the sense described in the earlier part of this address. They are inherited, they vary, they are selected, and evolve like other characters. The distinction so often drawn by psychologists between instinctive behaviour said to be inherited and intelligent behaviour said to be acquired is as misleading and as little justified in this case as in that of structural characters. Time will not allow me to develop this point of view, but I will only mention that instinctive behaviour is carried out by a mechanism developed under the influence of stimuli, chiefly internal, which are constantly present in the normal environmental conditions, while intelligent behaviour depends on responses called forth by stimuli which may or may not be present. Hence, the former is, but the latter may or may not be inherited. As in other cases, the distinction lies in the factors and conditions which produce the results. Instinctive and intelligent behaviour are usually, perhaps always, combined, and one is not more primitive or lower than the other.

It would be a mistake to think that these problems concerning factors and environment, heredity and evolution, are merely matters of academic interest. Knowledge is power, and in the long run it is always the most abstruse researches that yield the most practical results. Already, in the effort to keep up and increase our supply of food, in the constant fight against disease, in education, and in the progress of civilisation generally, we are beginning to appreciate the value of knowledge pursued for its own sake. Could we acquire the power to control and alter at will the factors of inheritance in domesticated animals and plants, and even in man himself, such vast results might be achieved that the past triumphs of the science would fade into insignificance.

Mount Everest.

By LIEUT.-COL. H. H. GODWIN-AUSTEN, F.R.S.

IN the issue of NATURE of March 31 last, p. 137, I offered some remarks on the Mount Everest Expedition. I have now been asked to give some account of the progress made by the recent expedition, and to point out some facts of interest to men of science. I have some hesitation in doing this, as so much has been written by able officers, such as Brig.-Gen. the Hon. C. G. Bruce (*Geographical Journal*, January, 1921) and Major H. T. Morshead (Survey of India, March, 1921), who have done more and been at greater heights than myself.

The news which has come regularly and rapidly through the *Times* reports tells of signal success; fine work has been done, and a difficult task faced with all the enthusiasm such an expedition can create. Enthusiasm for mountain reconnaissance was displayed on the lamentable death of Dr. A. M. Kellas on June 5 at Kampa Dzong, one of the first to join the expedition; in truth, he was already worn out by previous exposure. He gave his life, but not before his knowledge of Himalayan travel and what the native porter can do must have been of inestimable value. Now the expedition has completed its first season's work with the object of reaching next year a point as high as possible on its flank, I can better attempt to show what there is of interest not generally known, what the great height of Everest indicates, and how much it is bound up with the physical features of a vast area and with the geology of the same. There is something more than Mount Everest being the highest peak in the world which is bringing it rather suddenly into notice and proving of interest to the general public. This something I hope to bring before the reader and increase his interest.

I am envious of the good fortune of those who may stand on the flank of Mount Everest. They will, indeed, be fortunate men, for, with a clear horizon, they will look over the world laid out before them; still more fortunate they will be if they can ponder on the many problems it presents. Would that we could recall Sir Joseph Hooker with his knowledge and power of observation. We must not forget what he accomplished with limited means—his mapping and botanical record; indeed, few books of travel are on a level with his "Himalayan Journals."

I would ask the reader first of all to look at a good map of India, noting particularly the scale of miles to an inch on which it is compiled. First, I would direct attention to the peak's association with a gigantic geodetical undertaking, the measurement of an arc of the meridian or the great arc series of triangulation which, starting at Cape Comorin, was carried for 1500 miles to Banog at the base of the Himalaya—systematic work too technical to explain here. It was the conception of Col. Sir George Everest, R.E., when Surveyor General of India, assisted by his successor, Col. Sir Andrew Waugh, R.E. Exact triangulation gives us the true latitude, longitude, and height of the many lofty peaks on the far-off Himalayan chain, with the names and position of which the public are becoming familiar. Among

them Everest is the culminating point, 29,202 ft. above sea-level. The great geodesist, George Everest, introduced compensation bars in the measurement of base lines, and measured many with marvellous exactitude; he perfected instruments and produced a theodolite with a circle of 36 in. diameter; he invented also the heliotrope to supersede the pole when observing angles. The Survey of India owes everything to his creative genius, and Mount Everest is the finest monument to his memory. More than this, the survey now in progress in Thibet under Col. D. Ryder, R.E., the present Surveyor General of India, is extending the triangulation to the north, so that of the great arc may follow and be continued many miles further. Pendulum observations will also be feasible, and all will combine to give us a greater knowledge of the figure of the earth's crust and of those irregularities which cause the deviation of the plumb line from its normal direction.

Mount Everest, in common with all lofty points, looks over many thousand square miles of the earth's surface, which has seen enormous changes with which the height of the mountain itself is closely connected. For instance, the Garo Hills are seen from it, 250 miles distant on the south-east. They mark the western extremity of the Assam Range, one which is geologically recent and of elevation corresponding with that of the Sivaliks in Nepal which Everest overlooks. The view will embrace the great deltas of the Ganges and Brahmaputra; the courses of the main rivers will be followed by their wide, sandy beds as they issue from the mountains and flow to the sea, displayed as on a map—and what a changing map it has been—how affected by seismic action—a map of absorbing interest. Mount Everest is close upon the southern face or scarp of what may be termed an ancient plateau of denudation, well shown in Photograph 5 reproduced in the *Geographical Journal* for October, which depicts what we see at the present day, a surface configuration after thousands of years of wear and tear. The high plateau type of country of great elevation, none of it below 14,000 ft., can be said to commence in Rupshu, is continued on the Pangkong Lake, and widens out rapidly in Rudok. It is fairly well populated by a hardy race having many good qualities; crops are raised with difficulty, but enormous flocks and herds are reared. Denudation began with the very earliest Sivalik deposits, and continued until a quite recent Glacial period, one of extreme conditions. Even here, in latitude 28°, the glaciers were of great extent, though nothing compared with the lengths they attained in the north-west Himalaya when the Indus valley at Skardo was filled with ice and moraines, and even in the valley of Kashmir, latitude 34°, the Sind valley glacier extended to the valley itself not far from Srinagar, and was some forty miles long. Although hundreds of travellers pass up and down this beautiful valley, how very few of them know of this, yet the rocks, ground by the ice and striated by the stones which were embedded in it, are clearly to be seen.

During the Glacial period a great ice cap covered all the country here; and the work it performed is shown in the rounded outline of the spurs given off from Mount Everest.

In the letter of October 2 from Kharta, published in the *Times* of October 21, we have the first record of the geological structure of the Everest mass. It is short but worthy of notice. Col. Howard Bury says: "Immediately to our left towered up Makalu's great cliffs of white granite, so steep as to be snow free; it is a most imposing and marvellous mountain, looking incredibly thin, so perpendicular are its sides." Is this granite intrusive? Judging by analogy, it is. What Everest is composed of we have yet to learn. We have some data to guide us in Sir Joseph Hooker's diary of the Tambar valley at its southern end, where, on the Pemmi River, at about 2260 ft., he recorded ("Himalayan Journals," vol. 1, p. 192, 1854): "The rocks above 5000 feet were gneiss; below this cliffs of very micaceous schists were met with, having a north-west strike and being often vertical; the boulders again were always of gneiss." This strike (the prevailing one in this area) would extend towards Everest, and indicates what may be expected there.

The valley of Nepal came into existence with the great movements in late Tertiary times, when the Sivaliks were compressed and elevated on a belt of 1500 miles. A roll in the strata formed the Dun through which the waters of the Kosi and Gandak, keeping pace with the elevation, slowly cut their exit to flow into the ancient depression of the Bay of Bengal. The Nepal valley is therefore, in its physical features, similar to that of Assam on a very much smaller scale; that of the Deyra Dun is on a still smaller one. Looking to the Sikkim side, situated only fifteen miles from the plains, and towering above them, is the conspicuous point Gyepmochi, 14,418 ft. high. I know it well; it is of intrusive granite. It is connected with Kangchenjunga by the high, parting range, crossed at the Jalap La. Chamalarhi, 23,930 ft., which is seen from this direction on the north, has been said to be of an intrusive rock.

Going back to the Glacial period, it is worthy of notice, as not generally known, that from Gyepmochi deposits of morainic type extend to the plain of the Bhutan Dooars. A stream of large blocks of granite (one 10 ft. long) can be followed for eight miles, and is a conspicuous feature. A similar extension of ice action may be looked for south of Mount Everest, but not at so low a level, in the Nepal valley.

The next main valley beyond Gyepmochi, having its sources in Thibet, is the Am-mochu. The scarp lies south of Chumbi, as is shown in the steep fall in the bed of the river to Tsangbe. As it nears the plains it flows directly on to them; there is no Dun, but a massive limestone of unknown age brought up by a great fault occurs at

Balla, and thence, by the name of the Bura Torsa in the plains, the stream goes to join the Brahmaputra opposite the Garo Hills. Curiously enough, the Sivalik or Tertiary formation is absent at Balla, but it may be hidden beneath the recent alluvium. For twenty-five miles it is not visible, but at Buxar the Sivaliks suddenly reappear in considerable thickness, and contain abundant fossilised boughs of trees, indicating a forest-clad country on the north when they were laid down. These sandstones continue without a break and with varying breadth to far-distant Eastern Assam at the base of the Abor Hills.

To see the Tertiaries again as exemplifying the extent of Himalayan denudation one has to cross the broad alluvial valley of the Brahmaputra some 100 miles south, where they lie up against the Assam Range and contiguous to the intrusive granite there. They can be followed to Sylhet, to Jaintia, and the Naga Hills, rising in altitude until they reach in the latter country a height of 10,000 ft., the whole thickness being exposed from base upwards. The geological evidence goes to show that this late elevation of the Assam Range diverted the direct courses of the Subansiri and Tsanspu of Thibet which originally flowed through Burma to the sea into the present less direct route into the Bay of Bengal, and completely altered the ancient geography, and particularly the features of the Gangetic Delta.

I have mentioned granite intrusion. This leads me to refer to a very recent contribution in the Journal of the Geographical Society, September, 1921, p. 199, by Col. Sir Sydney Burrard, "On the Origin of Mountain Ranges." He asks: "Have they been elevated by horizontal compression of the surface, or by vertical uplift from below?" Further on: "It is difficult to be satisfied with the theory that mountains have arisen from horizontal compression, and we have to face the question: What is the force that has raised mountains?" (in this case the Himalaya). Again, on p. 200: "The highest summits are generally composed of granite, and the granite masses are believed to have risen out of the crust." I follow and agree with him, adding that actual observation is better than the many theories that have been put forward, such as that of Col. E. A. Tandy, R.E., "that falling stones sink by their own weight into the crust as though the latter were molten."

In Baltistan I was first struck by the evidence that the granite was intrusive, and I had the support of Gen. McMahon (*Geological Magazine*, 1897, p. 304), and discussed it with him. I came to the conclusion that granite intrusion has done more to elevate the Himalayas than any other force. It penetrates the metamorphic rocks, and has carried them up with it, and it can be followed for an enormous distance on the outer face of the great range, though always in the same relative zone.

In Nepal we have no data to go by, but at the Kali River, in longitude 80°, the granite—evidently intrusive—mapped by Capt. Herbert in 1815, after the Nepal War, is a conspicuous feature at Nynee Tal. The well-known Chor Peak near Simla extends it, while at Dharmsala is the most remarkable out-pouring forming the Dhauladhar, where, as the late Gen. C. A. McMahon points out, it is twelve miles broad. The Chatadhar extension, where I have seen and mapped it myself, is seven miles broad—where it has carried up the Nummulitic formation to the crest of the range—and in its plastic-looking state appears to lie above the Eocene and Pleistocene formations, compressing them and turning them over to a high, reversed dip. With such breadths of intrusion we have not far to go to find a cause for the folding and faulting of the Sivaliks rocks. In Kashmir similar granite intrusion is met with on the Pir Panjal and on the Kajnag Range west of Baramulla, up to Mozufferabad, with inversion of the Eocene on the south.

In the *Times* report of October 21 are the truly sensational headlines, "Wild Hairy Men," "Human Footprints." I fear the missing link has not yet been found; nevertheless, the observation has interest, and can be explained by the fact that a large species of monkey, probably of the genus Semnopithecus, the Hannman, or Lungur, has found its way from the Nepal side into Thibet, and has been reported to extend north of the Tsanspu. The late Capt. C. G. Rawling, R.E., in his excellent book, "The Great Plateau" (pp. 222, 223), tells how Capt. H. Wood, R.E., saw a troop of monkeys in November at Sangsang, which is nearly due north of Mount Everest; unfortunately, it was too late in the day to follow them and secure a specimen. These animals live there all the year round—a very interesting fact—and to be visible at 500 yards it must be a large species. Even on the slopes of Everest this monkey, which is omnivorous, would find plenty to live on, for the hare found everywhere in this region is abundant and easily caught in its forme after a cold night. A Lungur could in a few hours be down in warmth on the Nepal side, and in all probability the footprints were those of one retiring before the advent of the expedition camp. Mr. Briant H. Hodgson, who was for so many years resident at Katmandoo, brought together a splendid collection of mammals and birds, and he is not likely to have missed the existence of a new monkey in the valley of Nepal. I find that in August, 1834, he exhibited his extensive series of skins of mammalia at a meeting of the Zoological Society of London. An abstract of the species shown is given (Proc. Zool. Soc., p. 95, 1834), and it is stated that *Semnopithecus entellus* of F. Cuvier "has been introduced by religion into the central district (*i.e.* of Nepal), where it flourishes, half-domesticated, in the neighbourhood of temples." What more likely than that it has met the same happy protection in Thibet, the only part of the world where all living creatures can live in peace?

Obituary.

SIR CHARLES DOUGLAS FOX.

ONE of the last representatives of a generation of distinguished engineers, Sir Douglas Fox died on November 13 in his eighty-second year. His father, Sir Charles Fox, had assisted Ericsson in building the "Novelty," one of the three locomotives which competed at Rainhill in 1829, and as a member of the firm of Messrs. Fox, Henderson and Co. constructed the Crystal Palace in Hyde Park in 1850–51.

Articled to his father at the age of seventeen, Sir Douglas Fox acted as resident engineer of the Witney and Ramsey railways. In 1863 he was taken into his father's firm, which still subsists with the title Sir Douglas Fox and Partners. In this relation he was responsible for the construction of the London, Chatham, and Dover, and the London, Brighton, and South Coast Railways. He became consulting engineer to the Queensland Government Railways and to various railways in South Africa. Amongst the latter may be mentioned the Beira Port and Railway, and the Rhodesian railways, and the remarkable bridge over the Zambesi river at the gorge below the Victoria Falls. With Mr. Brunlees Sir Douglas was engineer for the Mersey Tunnel, and with Mr. Greathead for the Liverpool overhead railway, a new type of construction in this country. In the Argentine he was consulting engineer for several railways. When the Manchester, Sheffield and Lincolnshire Railway became the Great Central, Sir Douglas's firm was responsible for the works on the Southern and Metropolitan divisions and the Marylebone terminus. Sir Douglas was interested in the London traffic problem, and constructed the Great Northern and Hampstead tube railways. His firm are consulting engineers to the Channel Tunnel Co.

Sir Douglas Fox was president of the Institution of Civil Engineers in 1899–1900, and received the large party of American civil and mechanical engineers who came to England in that year. He contributed papers to that institution (in collaboration with his brother, Sir Francis Fox, and some of his chief assistants), and took part in important discussions on excavating machines; long-span bridges; broad-gauge, narrow-gauge, and light railways; Indian tramways; break of gauge; resistances on railways; and other subjects.

Sir Douglas Fox took an active part in the foundation of the British Standards Committee (now Association). This is doing an immense work in preventing waste of effort and facilitating production in engineering manufacture.

W. C. U.

PROF. A. S. DELÉPINE.

PROF. AUGUSTE SHERIDAN DELÉPINE, whose death was announced in NATURE last week, was educated in Paris, Geneva, and Lausanne, graduating in science at the last-named. He then proceeded to the University of Edinburgh, where he pursued medical studies, graduating with first-class honours in 1882. His interest from the first centred in pathology and in the then new science of bacteriology, and after acting for a time as demonstrator in these subjects at Edinburgh he settled in London, and soon afterwards was appointed demonstrator of pathology and curator of the museum at St. George's Hospital, where he did excellent work. In 1891 Delépine was appointed the first Procter professor of pathology and morbid anatomy in the University of Manchester. Here he organised the pathological department and designed the new buildings of the department. During his tenure of this professorship he carried out many investigations of a public health character, so that when, twenty years later, a department of public health was established at the University, he resigned the chair of pathology and was appointed to the new chair of public health and bacteriology and to be director of the public health laboratory, posts which he retained until his death.

At the laboratory Prof. Delépine gave instruction to a large number of graduates proceeding to the diploma of public health, some of whom assisted in conducting research work, while others surveyed the health of the district by inquiries and reports upon the incidence and spread of preventable disease. In this way close co-operation was maintained between the laboratory and the public health department of the city.

Among his researches may be mentioned his report to the Local Government Board in 1908 on the prevalence and sources of tubercle bacilli in milk, the connection between summer diarrhœa and food-poisoning (1902), and his report to the Manchester City Council on the conditions necessary to obtain a clean milk supply (1918).

During the war Prof. Delépine did good work in a consultative capacity as sanatarian and bacteriologist, and in particular investigated the nature and prevention of trench-foot, a malady which in the early days of the war was costing the Allied Armies many lives and an enormous amount of disability, and which he showed was due to a combination of damp, cold, and constriction.

Prof. Delépine was a warm and genial friend, and his place will be hard to fill. The tragedy of the loss of his only son during the war doubtless conduced to the ill-health from which he suffered of late.

R. T. H.

M. HENRY BOURGET.

WE regret to announce the death last September, after a long illness, at the age of fifty-seven years, of M. Henry Bourget, director of the Marseilles Observatory. After taking his degree, in which he gained distinction both for literary and mathematical studies, M. Bourget

was at Toulouse Observatory for twelve years under M. Baillaud, and carried out a successful programme of stellar photography with the large reflector. He also continued his mathematical researches, obtaining the doctor's degree for a thesis on hyperabelian groups, and helping in the editing of the works of Hermite. He took a large share in the photography of the Toulouse zone of the astrographic catalogue, in the Eros programme of 1900, and observed the total solar eclipses of 1900 and 1905 from Elche and Guelma.

In 1907 M. Bourget became director of the Marseilles Observatory, when he introduced the seismograph, the prism-astrolabe for time determination, and the reception of wireless signals from the Eiffel Tower. He also studied with MM. Fabry and Buisson the internal movements in the Orion nebula. He later introduced the Marseilles Circulars and the *Journal des Observateurs*, which have proved very serviceable for the distribution of information concerning comets and minor planets. A. C. D. C.

THE death of Lieut.-Col. P. G. VON DONOP, which occurred on November 7, at the age of seventy years, is recorded in *Engineering* of November 11. He obtained a commission in the Royal Engineers in 1871, and in 1899 was appointed Inspecting Officer of Railways under the Board of Trade. His name was well known in connection with inquiries into railway accidents.

THE death of Prof. CARLTON JOHN LAMBERT on November 6 is announced in *Engineering* of November 11. Prof. Lambert was seventy-seven years of age, and for several years was professor of mathematics, physics, and mechanics at the Royal Naval College, Greenwich. He was elected an associate member of the Institution of Naval Architects in 1896.

WE regret to see the announcement of the death on November 16 of PROF. P. THOMPSON, professor of anatomy at Birmingham University, at the age of fifty years.

IT is with much regret that we see the announcement of the death, on November 22, at seventy-six years of age, of the distinguished philosopher, M. EMILE BOUTROUX, member of the Institute of France.

Notes.

THE new skull from Rhodesia described by Dr. A. Smith Woodward in last week's NATURE was exhibited by him at a meeting of the Zoological Society on November 22. The skull, which was found in the Broken Hill Mine at a depth of 60 ft. below water-level and 90 ft. below ground-level, is in a remarkably fresh state of preservation. It is much broken on the right side and the lower jaw is missing. The brain-case is of modern human type, and the bone not thicker than that of the ordinary European; the capacity, though not yet accurately determined, is clearly above the lower human limit. The orbits are large and square, with pronounced overhanging ridges much extended laterally. The forward position of the foramen magnum indicates that the skull was poised on an upright trunk. The palate is large, but typically human, and adapted to perfect speech. It is remarkable that the teeth are much affected by caries. The lower jaw must have been massive and larger than the Heidelberg jaw. The appearance of flatness of the frontal area suggests a comparison with *Pithecanthropus erectus*. Dr. Smith Woodward was inclined to find the nearest approach to the Rhodesian skull in the Neanderthal type from La Chapelle aux Saints in France. Though markedly modern in regard to the brain-case, in its facial characters, while it is essentially human, it appears to hold a position between the gorilla and Neanderthal man. Fragments of the long bones, both femur and tibia, which have been found indicate that, unlike Neanderthal man, Rhodesian man walked in a perfectly upright posture. Dr. Smith Woodward regarded Rhodesian man as possibly a later development than Neanderthal man, but Prof. Elliot Smith suggested that he might represent a primitive type of which Neanderthal man might be a highly specialised form.

THE Council of the Institution of Electrical Engineers has elected Lord Southborough to be an honorary member of the institution. Lord Southborough, who is probably better known to men of science as Sir Francis Hopwood, has long been associated with electrical progress in this country, and rendered valuable services to the Institution of Electrical Engineers in connection with the obtaining of a Royal Charter and Royal Patronage, by his enthusiastic help and counsel, and by active co-operation with the charter committee. He is a member of the Board of Control of the National Physical Laboratory, and has been for many years closely associated with the problem of railway electrification.

THE inaugural meeting of the Empire Forestry Association was held in the Guildhall, London, on November 16. The object of the association is to federate in one central organisation societies and individuals interested in the growth, marketing, and utilisation of timber throughout the Empire. The association will publish a Journal, advocating a constructive policy of conservation and development in the various Dominions, Colonies, and India. It will collect and publish facts as to existing forestry conditions and timber requirements of the Empire. A room in the Imperial Institute will be at the disposal of the association for the display of the commercial timbers which are produced in countries under British rule. A Royal charter has been granted to the association. The secretary is Mr. T. S. Corbett, 17 Victoria Street, London, S.W.

THROUGH an advertisement in the *Times*, Prof. F. Soddy issues a warning "against the fraudulent use of a letter written by him referring to tests made by him of a process alleged to make gold."

MR. R. G. BARKER, of the British Dyestuffs Corporation, has been appointed scientific director of the British Launderers' Research Association.

THE *British Medical Journal* announces that the Swedish prize entitled the Berzelius medal has been conferred on Prof. E. Abderhalden, of Halle, for his researches on biochemistry.

AT the ordinary scientific meeting of the Chemical Society to be held in the lecture hall of the Institution of Mechanical Engineers, Storey's Gate, on Thursday, December 8, at 8 p.m., Prof. J. W. Gregory will deliver a lecture entitled "The Genesis of Ores."

THE Molteno Institute for Research in Parasitology is to be opened by Earl Buxton at Cambridge on Monday next, November 28, at 3 p.m. The new institute is a gift to the University from Mr. and Mrs. Percy A. Molteno.

THE council of the Royal Meteorological Society has awarded the Symons memorial gold medal for 1922 to Col. Henry George Lyons, F.R.S., for distinguished work in connection with meteorological science. The medal, which is awarded biennially, will be presented at the annual general meeting on January 18 next.

NOTICE is given that applications for the Government grant for scientific investigations for 1922 must be received by, at latest, January 1. They must be made upon forms obtainable from the Clerk to the Government Grant Committee, Royal Society, Burlington House, W.1.

APPLICATIONS for grants from the Andrew Carnegie Research Fund in aid of research work on the metallurgy of iron and steel are now receivable by the council of the Iron and Steel Institute. Application forms may be obtained from the secretary of the institute. They should be completed and sent in before the end of February.

AT the meeting of the London Mathematical Society to be held at 5 p.m. on Thursday, December 15, in the rooms of the Royal Astronomical Society, Burlington House, W.1., Mr. J. H. Jeans will deliver a lecture on "The New Dynamics of the Quantum Theory." Members of other societies will be welcome.

THE following were elected officers and members of council of the London Mathematical Society at the annual general meeting held on November 17:—*President:* Mr. H. W. Richmond. *Vice-Presidents:* Mr. J. E. Campbell, Mr. A. L. Dixon, Dr. W. H. Young. *Treasurer:* Dr. A. E. Western. *Secretaries:* Mr. G. H. Hardy, Dr. G. N. Watson. *Other Members of the Council:* Dr. T. J. I'A. Bromwich, Dr. L. N. G. Filon, Dr. H. Hilton, Miss H. P. Hudson, Mr. A. E. Jolliffe, Mr. J. E. Littlewood, Mr. E. A. Milne, Dr. J. W. Nicholson, and Mr. F. B. Pidduck.

AT the meeting of the Royal Geographical Society on Monday, November 21, the president announced that Brig.-Gen. the Hon. Charles Bruce has been offered the post of chief of the Mount Everest Expedition for next year, and has accepted the invitation. From an account just received by the society from Mr. Mallory of his final and successful effort to reach the North Col, 23,000 ft., it is understood that the way from there to the crest of the north-east arête is easy. Whether men suffering from the increasing lassitude which the ascent will produce can prevail against the wind and snow on the last 6000 ft. of that exposed arête is what next year's expedition will have to determine.

THE *Times* announces that the advance party of Mr. V. Stefansson's new Arctic expedition has arrived at its base on Wrangell Island, some 160 miles north of North Cape, Eastern Siberia. The main party of the expedition is expected to leave Nome, Alaska, next March or April. Its chief object is to explore the Beaufort Sea in order to discover if any land exists in that uncharted area. Mr. Stefansson believes that this can best be accomplished by small parties travelling over the ice, depending on seals for food, and thus able to remain for long periods away from the base. Wrangell Island itself has been imperfectly explored by Americans and, in 1914, by the survivors of the *Karluk*, the ship of Mr. Stefansson's former expedition. No further details of the present expedition are yet available.

IN a paper read before the Royal Society of Arts on November 9 Mr. D. R. Wilson gave a summary of the work of the Industrial Fatigue Research Board, the activities of which have, unfortunately, been curtailed owing to the demands in the interests of "national economy." The study of industrial fatigue is of quite recent origin. Its effects can be judged in various ways, notably by the rate of output, which follows a well-identified change throughout the working day. In some cases diagrams for hourly output throughout the week also reveal cumulative fatigue, *i.e.* a distinct diminution of efficiency as the week proceeds, and a corresponding improvement after the recuperative pause at the week-end. The effects of climatic conditions, giving rise to seasonal variations in output in certain industries owing to alterations in conditions of temperature, humidity, etc., are also interesting. A noteworthy fact is that, according to researches in the silk-weaving industry, output suffers a 10 per cent. diminution under artificial light as compared with daylight. Such work has a direct bearing on national efficiency and productive power. It is probable that much assumed "slackness" is due to causes outside of the control of the worker. It is a pity that these researches should be limited by lack of support.

AT the opening meeting of the Illuminating Engineering Society on November 15 an account of recent progress in connection with illumination was presented by Mr. L. Gaster, who referred to various recent official reports dealing with factory lighting, the effect of kinema lights on the eyesight of actors in studios, and motor headlights, as illustrating the interest now taken by Government Departments in various aspects of illumination. Afterwards a series of short demonstrations of novel applications of artificial light was given. This included several new forms of motor-car headlights, systems of "artificial

daylight," new neon electric lamps used for letter-signs, etc. The last-named exhibit was of considerable scientific interest in view of the novel principle of using neon gas as a luminous medium instead of a filament within a lamp-bulb of the ordinary standard size. Another striking demonstration illustrated the application of ultra-violet rays for the purpose of distinguishing genuine precious stones from spurious ones. Most gems fluoresce under strong ultra-violet light. Not only is the effect different in a genuine gem from that met with in imitations, but it is even possible to discriminate, by means of the difference in the colour of the fluorescence, between gems of the same kind from different districts. It was shown that Indian pearls can be readily distinguished from Japanese pearls by the aid of ultra-violet light, although by ordinary light they can be detected only with great difficulty. Ultra-violet light does not, however, enable "cultured" to be distinguished from ordinary Japanese pearls.

"SCIENTIFIC Men as Citizens" was the subject of an address by Sir Richard Gregory to an open meeting of the Cambridge branch of the National Union of Scientific Workers on November 16. In the address the theme was developed that modern civilisation differs from civilisations of the past, especially in wealth and power, almost entirely as the result of science and its application to human affairs. How comes it that the scientific man, as such, does not occupy a position in the community in any way commensurate with what he has done for modern civilisation? The reason appears to lie in the failure of scientific men as a body to grasp their own significance in the social complex, their failure to take any interest in the relation of their work and its application to the life of the community, their failure to impress their own importance and the importance of their work upon the imagination of the public, upon Governments, and upon leaders in industry. Broadly speaking, modern wealth and industrial expansion are directly due to scientific men, but men of science as such have taken little part in trying as citizens to control the proper uses of the riches with which they have helped to endow the nation. Scientific men should now exert direct influence in the State, and the motto of any organisation or union they may form should be, "The interests of science are the interests of the community, and the interests of the community are the interests of science." Sir Ernest Rutherford, who followed Sir Richard Gregory, said that the difficulty was that scientific men, both by temperament and training, were unfitted for the so-called political world. The remedy was for scientific men to be represented by men educated and trained in science, but who also possessed ability for public affairs or journalism. Prof. A. C. Seward emphasised the need for, and the value of, increased scientific education in schools. Prof. J. Stanley Gardiner, president of the Cambridge branch of the union, occupied the chair at the meeting.

A VERY remarkable kinematograph film, illustrating the method by which the cuckoo disposes of its eggs, and the subsequent behaviour of the young, was exhibited at the scientific meeting of the Zoological Society on November 8. For some years these matters have formed the subject of very patient and methodical study by Mr. Edgar Chance, and this summer he contrived, after an elaborately worked out plan, to summarise his results with the aid of a kinematographer carefully concealed within a shelter of leaves and bracken. Hitherto it has been the accepted belief that the cuckoo deposited her egg upon the ground and then conveyed it to the nest of her dupe in her beak. This film showed clearly enough that, as a matter of fact, the bird lays the egg within the nest, which, at any rate in the case of meadow-pipits' nests, she leaves tail foremost, apparently to avoid displacing the "run" made by the owners of the nest. As she leaves she takes in her beak one of the eggs of the pipit, and presently eats it. The "planing" down of the cuckoo from a high tree, and the alighting within a few feet of the nest, were most realistically shown. But the most wonderful of the whole series of pictures were those which showed the young cuckoo, though but two days old, blind, and naked, making the most determined efforts to raise its foster-brothers on to its back and up over the edge of the nest, thrusting its lean limbs backwards to assure itself by the sense of touch whether its efforts had succeeded. There was something indescribably diabolical and horrible about the whole of the proceedings. The first attempt failed, the downy, struggling body of the nestling to be ejected being saved from falling over the edge of the nest by a projecting twig. At this juncture the foster-mother returned and, unconcernedly feeding both her own youngster, gasping on the rim of the nest, and the young cuckoo, took both and brooded them. No sooner had she left them for more food than the work of eviction began afresh, and this time was accomplished successfully. Immediately after the only remaining rival was also thrown out.

AT a meeting of the Royal Statistical Society on November 15, Sir R. Henry Rew delivered his second presidential address, taking as his subject "The Progress of Agriculture." He pointed out that the total land area of Great Britain is now 56¾ million acres, and of the 52¾ million acres capable of productive use about 90 per cent. is so utilised in a greater or less degree. This area is not capable of any material extension. The proportion of arable land was 58 per cent. in 1869–78, and is now 48 per cent., but the prevalent belief that the output of British agriculture has declined overlooks the fact that the smaller arable area may, if devoted to other crops, produce a greater amount of food than the larger. By substituting potatoes for wheat, for instance, one-fifth the area would give about as much food. Fruit and vegetables have also largely replaced farm crops, while the extension of cultivation under glass has resulted in a great increase of output per acre. As regards livestock, comparing the ten years 1869–78 with 1912–21, there has been a net gain of about 750,000 beasts. There has also been a progressive and substantial increase in milk production during the past fifty years, the milking

herd having increased by 32 per cent., while the yield per cow has also been greatly increased. At the outbreak of war a larger quantity of food was being produced than at any previous period. During the war there was a setback in food production, the amount of cereal food being increased, but other kinds of food being markedly reduced. Whether the pre-war standard of total output has been regained is regarded as doubtful, but such facts as are accessible point to the conclusion that the output of food has been increased. Indeed, the agricultural land of the country is capable of producing more food, for on a large proportion of it the output is undoubtedly lamentably deficient.

"STATE Aid and the Farmer" forms the subject of an interesting paper contributed by Mr. S. L. Bensusan to the *Fortnightly Review* for September last. At the end of the war agriculture was at the summit of expectation, and the machinery required for the big development foreshadowed by the Prime Minister was gradually assembled. The passing of the Agricultural Act left the farmers under certain obligations to the State and to his employees, and in receipt of guarantees to enable him to face foreign competition in wheat and oats. The general policy of the Minister of Agriculture was to further the development of research, to protect the industry from diseases, to organise the agriculture of each county, and at the same time to make conditions as free as possible to encourage enterprise. But the Agricultural Act is now in large part repealed, and the farmers' position is not an enviable one. Not only have all costs increased, but the farmers have also to contend with the grave difficulties introduced by the Labour Bill and the new hours of labour. Farmers have a deep sense of grievance against the Wages Board, and they tend to take up an attitude towards the farm labourer that will lead to widespread disturbance throughout the rural area. It is of the utmost importance that farmers and labourers should meet in a spirit of justice and right endeavour, and should seek by co-operation to fuse into one the great agricultural interests of the country. The author concludes that "to-day the whole fabric of reconstruction is in ruins," whereas it probably would have been better if the Agricultural Act could have been suspended rather than destroyed, for the Act itself was based on sound principles and carried a promise, not for agriculture alone, but for the whole country.

IN a paper in the October issue of the *Quarterly Journal of Forestry* Mr. H. J. Denham directs attention to the fact that in calculating the times of fall of seeds of forest trees it has been the custom to neglect the resistance of the air. In the case of small seeds this leads to results much less than the actual time of fall, which is determined mainly by what is known in physics as the "terminal" or "limiting" velocity when the gravitational acceleration is exactly counterbalanced by the air resistance. The seeds experimented on attained this velocity in the first three metres of fall, and the time taken to fall the next four metres was observed. For certain species of ash and sumach the limiting velocity was 1·5 metres per second, for a maple 1·25 metres, while for a great many species of pine and cedar it is only about 0·8 metre per second. Seeds provided with a thin lamina frequently spin in falling, and the centrifugal force brought into play flattens the lamina and increases the time of fall. The bearing of the limiting velocity on the dispersal of seeds is obvious, and further research is desirable in the interests of forestry.

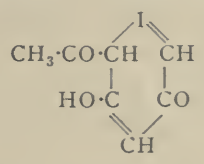
WE have received vol. 1, No. 1, issued on October 17, of the Bulletin of the Hill Museum, a newly instituted magazine devoted to Lepidoptera, and edited by Messrs. Joicey and Talbot. Great credit is due to Mr. Joicey for establishing this journal, and giving the results of studies carried out in his private museum at Witley to the entomological world. It is only a wealthy man or a public body that is in a position to amass collections on the scale carried out by Mr. Joicey. No apology is needed for this practice, since it is only by means of extensive collections that it is possible to carry out research into many of the problems concerning Lepidoptera. Work on variation and geographical distribution, for example, is very dependent upon access to large numbers of specimens. The appearance of an addition to the already long list of entomological periodicals may cause exclamation in some quarters, but it must be pointed out that most of the existing journals which usually accept papers on Lepidoptera are greatly taxed for space, and the high cost of publication has entailed an inevitable reduction in their pages. The sample issue before us is clearly printed and fully illustrated by twenty-four half-tone plates. Intending subscribers to this magazine should communicate with Mr. G. Talbot, curator, the Hill Museum, Witley, Surrey. The editors will be glad to hear from any societies or institutions desiring to exchange their publications. The subscription price is 30*s*. per annum post free.

MR. BAILEY WILLIS describes in *Science* (vol. 54, 1921) a new and interesting method of tracing the course of a great earthquake-rift by photography from an aeroplane. One of the most important rifts is that of San Andreas, along which the Californian earthquake of 1906 originated. It has been traced for a distance of about 600 miles, from Humboldt County in northern California to the Mohave Desert in the south of the same State. The fault is an ancient one, and has been the scene of innumerable movements which have given rise to pronounced topographic features. Mr. Willis's photographic survey was carried out during flights from San Francisco to Los Angeles and back, over a distance of about 400 miles. In the northern part, where rainfall is abundant and erosion efficient, there is not much to be seen after fifteen years. Farther south the rift can be traced by the linear arrangement, sometimes for 25 miles, of numerous landslide scars and small ponds. When it enters the desert country, in which the aridity of the climate limits erosion, the signs of the rift become more distinct and continuous.

From an altitude of 12,000 ft. it could be plainly seen like a large empty irrigation canal, stretching away for ten miles to the south until it was lost in the dust haze. Indeed, so permanent are the dislocation features in the desert regions that those produced during the earthquake of 1857 are still plainly visible. Mr. Willis thus concludes that the aeroplane can be used with advantage as a means of rapid geological reconnaissance in mapping large structural features.

In an article on rudder pressures and Airship R38, *Engineering* of November 11 it is pointed out that our information as to the actual forces operating on a ship when its rudder is in use is extremely limited and indefinite. In light structures such as those of airships it is therefore necessary to allow a more generous factor of safety for the structural portions which have to withstand these forces than for any other portion of the structure the straining action of which is more definitely known. It is possible to arrange the weights in an airship relative to the buoyancy, so that the shearing forces and bending moments operating on the structure as a whole may be reduced to very small amounts. If, however, more efficient control is required, and especially for movements in the horizontal plane, larger forces on the structure are involved, and the framing must of necessity be stronger. It is from airships that more definite information as to the actual pressures on rudders and other control surfaces can be obtained, since the actual pressure at various points can be measured simultaneously without much difficulty. Certain information on this point has already been obtained, but has not yet been published.

In the October issue of the Journal of the Chemical Society Prof. J. N. Collie and Miss A. Reilly describe the preparation of a new type of iodine compound. This is obtained by the action of iodine on the barium salt of diacetylacetone, and appears to contain iodine in the ring. The formula attributed to the compound is



On solution in water the iodine atom takes up the elements of water and becomes quinquevalent.

"The Legacy of Greece," edited by R. W. Livingstone, which is shortly to be published by the Oxford University Press, aims at giving an idea of the debt of the world to Greece in various realms of the spirit and intellect, and of what may still be learned from her. The chapters most likely to appeal to readers of Nature are Biology, by Prof. D'Arcy W. Thompson, Mathematics and Astronomy, by Sir Thomas Heath, Medicine, by Dr. C. Singer, and Philosophy, by Prof. J. Burnet.

Our Astronomical Column.

The Leonid Meteor Shower.—Mr. W. H. Denning records that this display proved rather a feeble one this year, and that very few of the meteors were seen. Miss A. Grace Cook, of Stowmarket, watched the sky for 3¼ hours on the very clear, frosty morning of November 11, and recognised six Leonids out of a total number of twenty-five meteors seen. The radiant point was in the usual position at 150+22°. Several other observers maintained a vigilant watch on the same date, but saw very few Leonids, though some brilliant objects were recorded from the minor showers of the period. There were radiant points in Taurus, Auriga, Cancer, and Ursa Major.

A New Suggestion to Explain Geological Climatic Changes.—Dr. Harlow Shapley contributes a paper on this subject to the *Journal of Geology*, vol. 29, No. 6. He has lately been observing the seventy variable stars in or near the Orion nebula, finding that they belong to various spectral types, and that their light-curves are peculiar, showing no regular periodicity, no extreme range of variation, and little resemblance to other known light-curves. He supposes that the changes are due to collision or friction with the nebulosity. He then notes that the motion of the sun is nearly straight away from the nebula, and that, assuming the distance as 600 light-years, the sun was in its neighbourhood some 9,000,000 years ago, in which case a variation of from 20 to 80 per cent. of the total light and heat may readily have taken place, more than enough to explain any of the changes postulated by geologists. He makes the further interesting notes that long-exposure spectrograms with the 100-in. reflector show the bright lines of hydrogen, nebulium, helium, carbon, and nitrogen; and that they also show a faint continuous spectrum in all parts of the nebula. This last fact makes the difference from the spectra of the spiral nebulæ one of degree rather than of kind.

Star Catalogues.—There have been extensive additions to published catalogues in recent months. Greenwich catalogues cover the zone 24–32° N. decl., and also the northern circumpolar region. The Astronomer Royal contributed a paper to the meeting of the R.A.S. on November 11, dealing with the proper motions of the latter catalogue. He showed that Drift I. was very strongly indicated, while Drift II. could be traced, but was much less conspicuous, as its apex was not far distant from the region of the catalogue. The Cape Observatory has issued a catalogue of the stars in the Backlund-Hough list, which was drawn up with the idea of covering the sky with a fairly uniform network of stars the places of which were to be well determined. Both Greenwich and Cape observations indicate a surprisingly large correction to the equinox previously employed; this correction has not yet been introduced into the Greenwich catalogues, but the Cape catalogue adopts the value −0·048s., deduced from observations of the sun, Mercury, and Venus. The cause of the correction is obscure; some part of it may be due to the introduction of the travelling-wire method of observing transits.

Washington Observatory has also published a catalogue of fundamental and zodiacal stars. It is particularly desirable to have the latter well observed, since they are employed to fix the positions of the moon and planets.

British Research on Tides.

OF recent years tidal research in this country has resumed the vigour which it showed during the fruitful years of Sir George Darwin's work and influence. Among official bodies, the Admiralty and Ordnance Survey have shown renewed activity in promoting tidal observation and research; but the revival is perhaps most closely linked with the interest shown in tidal problems by Mr. G. I. Taylor and by Prof. J. Proudman. The former has made several brilliant incursions into the field of tidal research, and has solved some important outstanding problems. His work on the tidal dissipation of energy in the Irish Sea has already inspired other workers to researches of a similar kind. Recently he has published a solution of the problem of tides on a rotating rectangular basin, a subject which had foiled the attempts of many former workers, including the late Lord Rayleigh; also, by an elegant investigation of the waves in a tapering channel with a sloping bed, he has lately explained the special tidal features in the Bristol Channel.

Free-lance work of this kind is essential to the progress of tidal theory, but not less necessary is systematic work on the immediate practical problems of tidal analysis and prediction. The establishment of a centre where such work is carried on is due primarily to the second-named mathematician, Prof. Proudman, backed by the University of Liverpool, the docks and shipping interests in that city, and later by the Department of Scientific and Industrial Research. The second annual report of the Tidal Institute of the University of Liverpool has just been issued, and describes the work completed or begun, under the direction of Prof. Proudman, during the past year. A fuller account of some of the work is contained in the report of the British Association Committee appointed "to assist work on the tides"; this report is drawn up by Dr. Doodson, who is the secretary both of this committee and of the Tidal Institute.

The main part of the year's work has consisted in the analysis of tidal observations, partly from a Liverpool tide-gauge, but chiefly from the Newlyn gauge. Newlyn is one of the four new tidal stations instituted by the Ordnance Survey. The analysis indicates that the errors remaining in the predictions made by former methods of harmonic analysis may amount to more than a foot, apart from the errors arising from the use of predicting machines. About half of the error may be due to the inadequate treatment of shallow-water effects, while the rest is due to tidal constituents not included in Sir George Darwin's schedule. A re-examination of the astronomical and dynamical theory of the tides has also been made by Dr. Doodson, who has found a number of terms large enough to demand consideration which are absent from the Darwinian schedule.

The shallow-water effects have been isolated by successive elimination of known or determined astronomical constituents. They show themselves, as theory indicates, in the introduction of components having periods a half, a third, a quarter, and so on, of the primary astronomical components—mainly, of course, of the semidiurnal component. Partly on a basis of theory, and partly as a result of experience with the Newlyn records, Dr. Doodson has formulated a rule connecting the amplitude and phase of these secondary constituents with the resultant semidiurnal tide on any day. The rule is that the shallow-water constituent of frequency $2n$ ($n=2, 3, 4$) is proportional in amplitude to the corresponding component in the nth power of the resultant semidiurnal tide, while the phases of these two components differ by an amount characteristic (like the factor of proportionality in amplitude) of the station and of the value of n. This rule is valuable because its commercial application is easy; correction tables for the purpose are readily prepared, since the corrections are functions merely of the time and height of the semidiurnal tide on any given day.

Much attention has been paid to improved methods of tidal analysis and of prediction by the use of the results of such analysis. Computational methods are favoured as against mechanical methods; a test of the accuracy of the tide-predicting machines used by the Admiralty and the India Office has indicated some serious errors in their results, and it is concluded that the labour of reading the curves afforded by the machines, with any pretence to accuracy, is comparable with the labour of direct computation, while the value of the results is greater in the latter case.

The discussion has so far been confined to the tides of short period, and these still present many unsolved problems. The long-period tides and the meteorological effects also afford an important field for research, which has yet to engage the attention of the committee and institute.

The Influence of Egypt on African Death Ceremonies.

AT a meeting of the Royal Anthropological Institute held on October 25, Dr. W. H. R. Rivers, president, in the chair, Mr. T. F. McIlwraith read a paper on "The Influence of Egypt on African Death Ceremonies." He said that there was strong evidence of Egyptian influence in modern Africa, particularly in the region south and west of the Sahara. In West Africa and the Congo preservation of the dead had a wide distribution. The methods employed included desiccation and pressure, frequently assisted by preservatives, such as honey, palm-wine, salt, and spices. Not only were these methods strikingly similar to those practised in Egypt, but there were also resemblances in arbitrary details, such as the plugging of the nostrils, sewing up the opening in the body, placing plates over the mouth and eyes, and wrapping the corpse in bandages. Equally important was the limitation of the preservation of the body to chiefs. Mummification had a slow growth in Egypt under favourable climatic conditions, but it was highly improbable that similar methods should have been evolved in the humid atmosphere of tropical Africa.

Coffins and anthropomorphic figures occur widely on the Guinea Coast and in the Congo, and are rare in East Africa. Coffins are usually the prerogatives of chiefs, and often occur in conjunction with some method of preservation of the body. Among the Baculé of the Ivory Coast a representation of the deceased is portrayed on the cover of the coffin, a feature highly suggestive of Egypt. Anthropomorphic figures are employed in a variety of ways in magical and religious ceremonies, and in a few cases are used to house the souls of the deceased, as was done in

Egypt. It is probable that the erection of a representation of the deceased over his grave belongs to the same complex.

The cumulative evidence of mummification, coffins, and anthropomorphic figures gives strong support to the belief that the resemblances between Ancient Egypt and Modern Africa are due to transmission of culture. Is this transmission of culture the result of direct influence from Egypt to Africa (or *vice versa*), or is it due to the common ancestry of Ancient Egyptians and Modern Hamites? This last possibility is untenable, since the history of mummification can be traced from its beginning in Egypt, whereas in Africa it appears to occur only in a fairly developed state. This further precludes the possibility of African influence on Egypt, leaving as the only solution that various Egyptian practices were transmitted to Africa, where they have survived, in a more or less degraded form, until the present day.

Why do these survivals occur in distant parts of the Continent rather than in the north and east? Two hypotheses are possible: (1) That elements of Egyptian culture were transmitted to various parts of Africa by land, but survive only in areas where pastoral peoples have not penetrated; (2) that seafarers established a centre of Egyptian civilisation on the Guinea Coast, whence their influence spread inland with ever-lessening intensity.

The presence in East Africa of a few isolated instances of the practices under consideration supports the first hypothesis. On the other hand, the evidence of Egyptian civilisation in West Africa raises the possibility of a settlement on the coast itself. It is probable that much of the culture of the Canary Islands was of Egyptian origin, and the islands may have served as a base for voyages further south.

In opening the discussion which followed the reading of the paper the president said that the question involved three distinct problems: (1) Was there any relation between burial customs in West Africa and those of Ancient Egypt? (2) Did the influence penetrate by land or sea, and why were these customs absent from the greater part of Africa? (3) What was the date of the movements by which they were introduced? Miss Murray said that regarding the evidence from the chronological, rather than from the geographical, point of view, she required further proof of connection. Similarity was no proof. For instance, the ceremonial of royal funerals in this country had been identical in many points with that of the royal funerals of Ancient Egypt; but it did not follow that they were connected. The types of mummification cited belonged to the earliest times.

Prof. Elliot Smith pointed out that the customs cited by the author, so far from being early in date, belonged to a small group of dynasties of the late Empire, ranging mainly from the nineteenth to the twenty-second dynasties. This gave the earliest date for the diffusion of these customs. They had spread by land across the Continent and down the Niger; but there was definite evidence of a later diffusion by sea in the sixth century B.C. The distribution should be compared with the occurrence of gold. Mr. Peake said that these customs must have been introduced at an early date, and clearly were not indigenous, as climatic conditions were not favourable to the independent development of mummification. The distribution was probably due, not to the occurrence of gold, but to the fact that an incoming people, arriving from the grasslands, would follow the line of least resistance along the open glades of the forest and the river valleys.

Mr. Torday suggested that the use of the coffin might be due to European influence, while the distribution was due not to gold—there was no forest gold—but to the fact that these customs had been reported by travellers who had followed the beaten track. Further, was there not more reason to believe that these customs had been introduced into Egypt from Africa rather than *vice versa*? Dr. Stannus said that the custom of plugging the nostrils of a corpse, on which stress had been laid, was widespread in Africa, and was intended to arrest the rapid setting in of decomposition through the agency of flies.

University and Educational Intelligence.

BRISTOL.—Prof. T. Loveday, principal of University College, Southampton, and formerly professor of philosophy at Armstrong College, Newcastle-upon-Tyne, has been appointed vice-chancellor of the University in succession to Sir Isambard Owen, recently retired.

CAMBRIDGE.—Mr. W. E. H. Berwick, University lecturer in mathematics at Leeds University, has been elected to a fellowship at Clare College.

The list of those who voted last month on the position of women at Cambridge has now been published. It shows a strong majority among the residents in favour of the compromise scheme. As had been generally surmised, this scheme was thrown out by the non-resident voter.

LEEDS.—Mr. E. C. Williams has been selected for the post of research chemist to the Joint Benzole Research Committee of the University and the National Benzole Association, and he was officially appointed by the council on November 16 last. Mr. Williams graduated in 1914 at the University of Manchester with first-class honours in the School of Chemistry. He was awarded the Mercer and Dalton research scholarships for research theses, and a special University prize for physical chemistry. His M.Sc. was gained by research, and later he was appointed research chemist to British Dyes, Ltd., where for the past four and a half years he has been engaged, not only upon laboratory research, but also on large-scale work and administration, as head of the department at the Dalton Works, Huddersfield, for the manufacture of intermediate products. Mr. Williams's work will centre at the University of Leeds in the Department of Coal-gas and Fuel Industries, where laboratory facilities are provided, but will also be carried out so far as may be found desirable on the plants engaged in benzole production and laboratories attached thereto.

LONDON.—The Senate has adopted a resolution that the recently erected inorganic and physical chemistry laboratories at University College should be named after the late Sir William Ramsay.

MR. E. R. WEIDLEIN has been appointed director of the Mellon Institute of Industrial Research, University of Pittsburgh.

THE Hampshire Field Club and Archæological Society has organised a course of six public lectures on topics of local archæological interest which are being delivered at Southampton. Two lectures have already been given, and it is gratifying to learn that the attendance has in each case been between 350 and 400, of whom nearly 300 were persons who had obtained serial tickets. We note that the lecturers are giving their services free, and all the profits made will be devoted to publishing original research.

It is announced that a course of instruction will be given in the summer of 1922 at the Official Seed Testing Station, Cambridge. The course will be limited to persons who are (*a*) nominated by seed firms who intend to offer employment to such nominees in their own seed-testing stations; or (*b*) recommended by universities, agricultural colleges, and institutions; or (*c*) approved by the council of the institute. An examination will be held at the conclusion of the course, and certificates will be issued to students who satisfy the examiners. The examination will also be open to practical seed analysts who have not attended the course of training. Applications for entrance forms should be made to the Chief Officer, Official Seed Testing Station, Cambridge, not later than May 1 next.

Leeds University Calendar for 1921–22 is a compact volume of some 600 pages, containing particulars which prospective students of the University would do well to consult. Lists are given of the members of the University Court, Council, Senate, Faculties, and Boards of Faculties, and the professorial and teaching staff. Details follow of the degrees and diplomas conferred by the University, and in most cases a syllabus of the work required is appended. Evening courses and extension lectures are also dealt with, and brief accounts are given of the origin of, and regulations affecting, the various fellowships, scholarships, and prizes awarded by the University. A summary is given of the number of students who attended courses in the University during the last two sessions; for both day and evening students an increase of about 200 on the 1919–20 figures is recorded—a sure indication of progress justifying the recent appeals for increased grants and donations.

The announcement of the intended retirement of Sir Philip Magnus from the Parliamentary representation of the University of London at the close of the present Parliament has been received with much regret. Sir Philip has represented the University of London since 1906, and he has been in intimate touch with it for upwards of fifty years, from the time when it was a mere examining body, however distinguished and serviceable, to the present day, when it is comprised of a closely co-ordinated variety of teaching institutions and incorporated colleges, yet still lacking a central home in which its activities as a teaching and examining body can be more efficiently concentrated and administered. Sir Philip will be much missed on his retirement from Parliament, where his great knowledge and experience of all educational matters were at the service of the House and of those engaged in their administration and promotion. He had been an active member of the School Board for London, but his most conspicuous service lay in his capacity of director of the technological examinations of the City and Guilds of London Institute, to which position he was appointed in 1880, followed by his selection in 1881 as a member of the Royal Commission on Technical Education. In his former capacity, by his wise measures and unfailing support, he greatly stimulated the development of technical instruction throughout the United Kingdom, and as a result of the latter the report of the Royal Commission created a deep and widespread interest which ultimately led to the enactment of the Bill for Technical Instruction of 1889, which has had such beneficent effects on our trade and industry. Sir Philip Magnus is a warm advocate of manual training in all schools, and he is no less concerned that all efficient private schools shall receive official recognition, believing that it is the only effective way of ensuring freedom and variety of subject and method.

Calendar of Scientific Pioneers.

November 24, 1864. Benjamin Silliman died.—The first professor of chemistry at Yale, and the founder and editor of the *American Journal of Science and Arts*, Silliman owed his reputation mainly to his lectures and writings on chemistry and geology. His son, also Benjamin Silliman (1816–85), was his successor at Yale.

November 25, 1884. Adolphe Wilhelm Herman Kolbe died.—A pupil of Wöhler, and, in 1851, the successor of Bunsen at Marburg, Kolbe effected the synthesis of acetic acid, the second organic compound to be produced artificially, and had an important share in the development of chemical theory.

November 25, 1913. Sir Robert Stawell Ball died.—Introduced to astronomy by reading Mitchell's "Orbs of Heaven," Ball, in 1874, became Royal Astronomer of Ireland, and in 1892 succeeded Adams as Lowndean professor at Cambridge. A most popular lecturer and writer, Ball was also a mathematician, and in 1910 published his great work on the theory of screws.

November 26, 1801. Déodat Guy Silvain Tancrède Gratet de Dolomieu died.—An indefatigable student of the volcanic regions of South Europe, Dolomieu is counted among the pioneers of geology, and his name is perpetuated by the word dolomite.

November 26, 1885. Thomas Andrews died.—Trained as a physician, Andrews held the chair of chemistry in the Queen's College, Belfast, where he carried out the researches in physical chemistry which led to his important discovery of the existence of a critical temperature above which a gas cannot be converted into a liquid by pressure alone.

November 26, 1896. Benjamin Apthorp Gould died.—The founder of the *Astronomical Journal*, Gould did valuable work for the United States Coast Survey, and organised the Argentine National Observatory at Cordoba. He was one of the first astronomers to use the camera as an instrument of precision.

November 28, 1876. Karl Ernst von Baer died.—One of the greatest Russian naturalists, von Baer, in 1827, discovered the mammalian ovum, and by his later work became the founder of comparative embryology. For many years he was librarian to the Imperial Academy of St. Petersburg.

November 28, 1914. Johann Wilhelm Hittorf died.—A student under Plücker at Bonn, Hittorf, in 1852, became professor of chemistry and physics in the University of Münster. He contributed to the study of spectrum analysis and electrolysis, and in 1869 discovered the nature of kathode rays.

November 29, 1694. Marcello Malpighi died.—Malpighi has been called the first of the histologists. A pioneer in microscopic anatomy, he was the first to see capillary circulation, and did important work on secreting glands and the anatomy of brain and vegetable tissue. Most of his life was spent at Bologna.

November 29, 1872. Mary Somerville died.—The first notable woman worker in science in Great Britain, Mary Somerville, in 1831, published her "Mechanism of the Heavens," based on the writings of Laplace, who said that she was the only woman who understood his works.

November 30, 1603. William Gilbert died.—Physician to Queen Elizabeth, Gilbert is the father of magnetic and electrical science. In 1600, the year he became president of the College of Physicians, he published his "De Magnete . . ." the first great physical work published in England. Of him Dryden remarked, "Gilbert shall live till loadstone cease to draw."

E. C. S.

Societies and Academies.

LONDON.

Royal Society, November 17.—Prof. C. S. Sherrington, president, in the chair.—P. A. **MacMahon** and W. P. D. **MacMahon**: The design of repeating patterns. The study and classification of repeating patterns in space of two dimensions is founded upon the simplest geometrical forms which happen to be repeats. These are employed as bases and are subjected to specified transformations which depend upon certain contact systems between the sides which are in contact in the assemblage. Repeats are of three varieties: the block, the "stencil," and the "archipelago." There is a further broad division into normal and abnormal repeats. A theory of "complementary repeats" is established. A contour can be drawn around every normal repeat in an infinite number of ways, such that the area within the contour, which does not belong to the repeat, is itself a repeat. The contour under specified conditions is itself the boundary of a repeat, which is therefore a combination of the original repeat and its complementary. Mr. G. T. Bennett finds that "every quadrilateral figure" is a repeat.—J. W. **Nicholson**: A problem in the theory of heat conduction. The temperature at any point in the external medium, and the rate of loss of heat from a cylinder, the surface of which is maintained, from some specified instant, at a constant temperature for all subsequent time, is found for any instant by the use of a generalised form of the Bessel-Fourier double integral. A solution can be obtained in a similar way when the temperature maintained on the cylindrical surface is not constant.—C. H. **Lees**: The thermal stresses in spherical shells concentrically heated. Thermal stresses in the material of a furnace of approximate spherical form due to differences of temperature, and the stresses due to pressures on the inside and outside surfaces, may be expressed in terms of the volume of the spherical surface through any point or of its reciprocal. The whole problem can be treated graphically. The increase of stress due to sudden changes of temperature of the inside surface is discussed.—R. A. **Fisher**: The mathematical foundations of theoretical statistics. The most efficient statistic has the least standard deviation; the efficiency of any other statistic is the ratio of number of observations required by the most efficient to that required by statistic under consideration in order to obtain a value of the same accuracy. The criterion of consistency applied to a method of estimation is a special case of criterion of sufficiency, which requires that the sufficient statistic shall include the whole relevant information provided by sample. Statistics obtained by the method of maximum likelihood are always sufficient statistics. Their standard deviation being easily calculated, the efficiency of any other statistic of known probable error may be found.—F. P. **White**: The diffraction of plane electromagnetic waves by a perfectly reflecting sphere. The series solution is transformed into a contour integral along a path of "steepest descents," and the value of this integral is determined approximately. The results obtained are in agreement with those obtained by other workers.—C. V. **Raman** and G. A. **Sutherland**: The Whispering Gallery phenomenon. Observations made in the Whispering Gallery at St. Paul's Cathedral and in laboratory experiments show that Rayleigh's theory of the phenomenon does not offer a complete explanation. The single belt of maximum intensity close to the wall contemplated by Rayleigh is obtained only in the limiting case when the radius of the reflecting circle is practically infinite in comparison with the wave-length. For more moderate values of the radius of curvature there is a succession of belts of alternately great and small intensity. The slight deviation from the condition of strictly circumferential wave-propagation postulated by Rayleigh gives rise to such effects.

Linnean Society, November 3.—Dr. A. Smith Woodward, president, in the chair.—J. **Groves**: Charophyta collected by Mr. T. B. Blow in Ceylon. The collection consisted of thirteen species, one of which was regarded as new; only one of them occurred in Europe. Many of the specimens were obtained from tanks which had been in use when large tracts of country, which are now lying waste, were in cultivation.

Zoological Society, November 8.—Dr. A. Smith Woodward, vice-president, in the chair.—R. I. **Pocock**: The external characters and classification of the Mustelidæ.—W. R. **Sherriff**: Evolution within the genus. Part 1. *Dendronephthya* (*Spongodes*), with descriptions of a number of species. Part 2. Description of species (Alcyonaria) taken by the *Siboga* expedition.—C. F. **Sonntag**: The comparative anatomy of the tongues of the mammalia.—V. Lemuroidea and Tarsoidea. VI. Summary and classification of the tongues of the Primates.—E. P. **Chance**: Investigation of the laying-habits of the cuckoo (*Cuculus canorus*) and the life of the young cuckoo. This communication was illustrated by a striking series of kinematograph films and photographs.

CAMBRIDGE.

Philosophical Society, October 31.—Prof. Seward, president, in the chair.—H. **Hartridge**: A new method of testing microscope objectives. The focussing points of rays from different zones, or the lateral displacements of an image formed by the rays from different zones, are determined. For the latter method either direct visual observation may be used or the displacements as recorded in a photographic plate can be afterwards measured.—J. E. P. **Wagstaff**: (1) Determination of the coefficient of viscosity of mercury. (2) A laboratory method of determining Young's modulus for a microscopic cover-slip.—J. L. **Glasson**: Some peculiarities of the Wilson ionisation tracks and a suggested explanation. The tracks of β-particles in the Wilson photographs form circular arcs of random radii length and direction. This may be due to magnetic fields produced by transient quasi-crystalline aggregations of water molecules. The existence of many cases in which two or more tracks have similar shapes supports these conclusions, as does the periodicity of the ionisation and the curvature of the α-ray tracks. Peculiar distributions of the α-rays emitted from radium emanation suggest that the atoms of emanation are polar, and that the field is polarised.—W. **Burnside**: (1) Convex solids in higher space. (2) Certain simply transitive permutation-groups.—G. H. **Hardy** and J. E. **Littlewood**: Some problems of diophantine approximation.—W. J. **Harrison**: The stability of the steady motion of viscous liquid contained between two rotating coaxial circular cylinders.—R. **Whiddington**: (1) Note on the velocity of X-ray electrons. (2) A laboratory valve-method for determining the specific inductive capacities of liquids.—Sir George **Greenhill**: Tides in the Bristol Channel.—M. J. M. **Hill**: The fifth book of Euclid's "Elements."—W. **Wirtinger**: A general infinitesimal geometry, in reference to the theory of relativity.

DUBLIN.

Royal Irish Academy, November 14.—Prof. Sydney Young, president, in the chair.—T. **Alexander** and J. T. **Jackson**: Polygons to generate diagrams of maximum

stress. The blackboard model polygon, with the two end sides long, and four short sides, was rolled over on a lath fixed to the board, while the apex drew five circular arcs. The vertical ordinates gave the square roots of maximum bending moments on a 42-ft. girder due to the transit of a 30-ft. 42-ton locomotive. The short sides of the polygon doubled are the distances apart of its five wheels, while the five spaces into which the span is divided by perpendiculars from the intersecting points of the arcs give, numerically, the loads on the wheels. The cycloid is an extreme case, and an interesting curve modified from it was shown, and a new pair of conjugate load areas that balance the linear circular rib and lead to a geometrical solution of the equilibrium of the semi-circular masonry arch.

PARIS.

Academy of Sciences, November 7.—M. Georges Lemoine in the chair.—C. **Richet**: An optical illusion in the appreciation of velocity.—G. **Charpy** and G. **Decorps**: The determination of the degree of oxidation of coal. An empirical method based on the extraction of the constituents of the coal by 50 per cent. soda solution at 100° C., and measurement by permanganate of the amount of oxygen required for the oxidation of the organic matter.—G. **Julia**: A class of functional equations.—H. **Villat**: Certain integral equations possessing an infinity of solutions with an unlimited number of arbitrary parameters.—K. **Popoff**: The development of an arbitrary function in series according to a suite of given functions.—P. **Boutroux**: The functions associated with an "autogenous" group of substitutions.—M. **Riabouchinski**: The general equations of movement of solid bodies in a perfect incompressible fluid.—M. **Michkovitch**: The rectifications of the ephemerides of the minor planets.—M. **Salet**: Spectrophotometry of stars containing carbon.—A. **Buhl**: The *rôle* of analytical symmetries in the relativist theories.—P. **Langevin**: The theory of relativity and the experiment of M. Sagnac. A proof that the generalised theory of relativity gives a quantitative explanation of Sagnac's experiment.—M. **Décombe**: The theory of the galvanic battery.—M. **Travers**: A new method for the estimation of fluorine at the ordinary temperature. Fluorine is obtained in the state of soluble alkaline fluoride, potassium silicate and a little hydrochloric acid added, and precipitated as potassium fluosilicate by potassium chloride. The precipitate is estimated by titration.—M. **Grandmougin**: The homonuclear dibromoanthraquinones.—E. **Rothé**: The use of radiogoniometry in the study of storms and of atmospheric "parasite" currents. It is possible to predict the weather from the observation of the parasite currents.—J. **Lacoste**: The relation existing between the directions of depressions and the directions of the maxima of the atmospheric parasites.—Mlle. Yvonne **Boisse** and P. **Marty**: The plurality of the eruptive apparatus of the Cantal massif.—R. **Souèges**: The embryogeny of the Boraginaceæ. The last stages of the development of the embryo in *Myosotis hispida*.—St. **Jonesco**: The formation of anthocyanine in the flowers of *Cobaea scandens* at the expense of the pre-existing glucosides. The experiments of E. Rosé, which gave negative results for glucosides in the non-coloured flowers are shown to be incorrect. Glucosides are always present, and the author holds that the colouring matters are produced at the expense of these pre-existing glucosides.—H. **Colin**: The graft of sunflower on the Jerusalem artichoke. Studies on the transformations of the carbohydrates.—A. **Kozlowski**: The formation of the red pigment of *Beta vulgaris* by oxidation of the chromogens. The chromogens extracted from the maritime beet and the white sugar-beet were white or light yellow. On oxidation these gave a red pigment spectroscopically identical with colouring matter from the red beet. The chromogens from the white beets have some properties in common with the saponins; they have a bitter taste, and produce froth and decolorisation of red-blood corpuscles.—P. **Dangeard**, jun.: The formation of aleurone grains in the albumen of the castor-oil plant. The observations described and illustrated lead to the conclusion that the formation of the aleurone grains is only a particular case of a more general phenomenon, the evolution of the vacuolar system.—E. **Chatton**: A new kinetic mechanism: syndinian mitosis in the plasmodial parasitic Peridinians.—M. **Baudouin**: A method for the determination of the minerals constituting prehistoric metallic axes: use of spectrum analysis. The presence or absence of tin is readily determined by the spark spectrum without mutilating the specimen.—F. H. **Quix**: The *rôle* of the otoliths in the spontaneous movements of animals during jumping and falling.—P. **Brodin** and P. **Huchet**: A new anti-anaphylactising substance, formaldehyde-sodium hydrosulphite.—G. **Truffaut** and M. **Bezssonnof**: The variations of energy of *Clostridium Pastorianum* as nitrogen-fixing organisms. The partial sterilisation of the soil by calcium sulphide increases, not only the number of *C. Pastorianum*, but also their capacity for fixing nitrogen.—C. **Levaditi** and S. **Nicolau**: Neurotropic affinity and the purification of the virus of vaccine.

CAPE TOWN.

Royal Society of South Africa, September 28.—Dr. J. D. F. Gilchrist, president, in the chair.—J. **Moir**: Colour and chemical constitution, pt. 15. A systematic study of fluorescein and resorcin-benzine. Colour-factors have been obtained by experiment whereby the colour of any halogenated fluorescein can be calculated. A preliminary investigation of resorcin-benzine derivatives follows.—J. D. F. **Gilchrist**: The origin of paired fins in fishes.

Books Received.

Australasian Antarctic Expedition, 1911–14. Under the Leadership of Sir D. Mawson. Scientific Reports. Series C: Zoology and Botany. Vol. 8, part 1: Echinodermata Asteroidea. By Prof. R. Koehler. Pp. 308+75 plates (Sydney: Government Printing Office.) 38*s*.

Stanford's New Map of the Pacific Ocean. 30 in. × 22½ in. (London: E. Stanford, Ltd.) Coloured sheet, 4*s*.

The Marketing of Whole Milk. By Dr. H. E. Erdman. (The Citizen's Library: Marketing series.) Pp. xvi+333. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 21*s*. net.

The Wisdom of the Beasts. By C. A. Strong. Pp. x+76. (London: Constable and Co., Ltd.) 5*s*. net.

Wisconsin Geological and Natural History Survey. Bulletin No. 55: Soil series, No. 27. Soil Survey of Northern Wisconsin. By A. R. Whitson and others. Pp. iv+46. Bulletin No. 58: Educational series, No. 6. The Geography and Economic Development of South-eastern Wisconsin. By Prof. R. H. Whitbeck. Pp. x+252. (Madison, Wis.)

Air Ministry: Meteorological Office. Geophysical Memoirs, No. 17: Simultaneous Values of Magnetic Declination at Different British Stations. By Dr. C. Chree. Pp. 175–200. 2*s*. net. Geophysical Memoirs, No. 18: Observations of Radiation from the Sky, and

an Attempt to Determine the Atmospheric Constant of Radiation. By W. H. Dines. Pp. 201–212. 1s. 3d. net. (London: H.M. Stationery Office.)

Agricultural Directorate: Ministry of Interior, Mesopotamia. Memoir III: Dates and Date Cultivation of the 'Iraq. By V. H. W. Dowson. Part 1: The Cultivation of the Date Palm on the Shat Al 'Arab. Pp. viii+75. 10s. net. Part 2: The Results of an Investigation into the Yield of Date Palms on the Shat Al 'Arab. Pp. vi+26+tables. 5s. net. (Cambridge: W. Heffer and Sons, Ltd.)

Chemical Warfare. By Brig.-General A. A. Fries and Major C. J. West. Pp. xi+445. (New York and London: McGraw-Hill Publishing Co., Inc.) 21s. net.

Transactions of the Royal Society of Edinburgh. Vol. 53, part 1 (No. 2). Shackleton Antarctic Expedition, 1914–17. Geological Observations in the Weddell Sea Area. By J. M. Wordie. Pp. 17–28+4 plates. (Edinburgh: R. Grant and Son; London: Williams and Norgate.) 4s.

Biologische Gesetze in ihren Beziehungen zur Allgemeinen Gesetzlichkeit der Natur. By Prof. Dr. J. Reinke. Pp. 31. (Leipzig: J. A. Barth.) 7.50 marks.

Life: How It Comes. A Child's Book of Elementary Biology. By S. Reid-Hayman. Pp. xiii+174. (Oxford: B. Blackwell.) 5s. net.

A History of Greek Mathematics. By Sir Thomas Heath. Vol. 1: From Thales to Euclid. Pp. xv+446. Vol. 2: From Aristarchus to Diophantus. Pp. xi+586. (Oxford: Clarendon Press.) 50s. net.

Report on the Economic and Natural Features of British Honduras in relation to Agriculture, with Proposals for Development. By W. R. Dunlop. Pp. iv+32. (London: Crown Agents for the Colonies.)

Einstein the Searcher: His Work explained from Dialogues with Einstein. By A. Moszkowski. Translated by H. L. Brose. Pp. xii+246. (London: Methuen and Co., Ltd.) 12s. 6d. net.

Cours Complet de Mathématiques Spéciales. By Prof. J. Haag. Tome 2: Géométrie. Pp. viii+661. (Paris: Gauthier-Villars et Cie.) 65 francs.

Science Universelle de l'Energie. VI.: La Relativité et les Forces dans le Système Cellulaire des Mondes: Nouvelle Etude de Cosmogonie scientifique. By Capt. S. Christesco. Pp. 302. (Paris: F. Alcan.) 12 francs net.

Les Maîtres de la Pensée scientifique: Collection de Mémoires et Ouvrages. Mémoires sur l'Electromagnétisme et l'Electrodynamique. By André-Marie Ampère. Pp. xiv+111. (Paris: Gauthier-Villars et Cie.) 3 francs net.

Les Maîtres de la Pensée scientifique: Collection de Mémoires et Ouvrages. Essai Philosophique sur les Probabilités. By Pierre-Simon Laplace. I. Pp. xii+103. II. Pp. iv+108. (Paris: Gauthier-Villars et Cie.) 3 francs net each.

Selection in Cladocera on the Basis of a Physiological Character. By A. M. Banta. (Publication No. 305, Paper No. 33, of the Department of Genetics.) Pp. ii+170. (Washington Carnegie Institution.) 2.50 dollars.

The Distribution of Vegetation in the United States as related to Climatic Conditions. By B. E. Livingston and E. Shreve. (Publication No. 284.) Pp. xvi+590+plates. (Washington: Carnegie Institution.) 9 dollars.

Observations made at the Royal Magnetical and Meteorological Observatory at Batavia. Vol. 39, 1916, containing Meteorological and Magnetical Observations made in 1916. By Dr. C. Braak. Pp. xxviii+118+3 charts. (Batavia.)

Recalculated Monthly Values of the Vertical Component and Inclination of the Magnetic Force at Buitenzorg, 1902–1910. (Appendix to "Observations made at the Royal Magnetical and Meteorological Observatory at Batavia," vol. 38, 1915.) Pp. iv+20. (Batavia.)

The Wheat Plant: A Monograph. By Prof. J. Percival. Pp. x+463. (London: Duckworth and Co.) 63s. net.

Virgil in Relation to the Place of Rome in the History of Civilisation. A Lecture given to Oxford University Extension Students. By Sir Herbert Warren. Pp. 36. (Oxford: B. Blackwell.) 2s. net.

Rural Organisation. By Prof. W. Burr. Pp. xiv+250. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 12s. net.

Nut Growing. By R. T. Morris. Pp. x+236. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 13s. net.

The Outline of Science: A Plain Story Simply Told. Edited by Prof. J. A. Thomson. Vol. 1, part 1. Pp. ii+40. (London: G. Newnes, Ltd.) 1s. 2d. net.

Morbid Fears and Compulsions: Their Psychology and Psychoanalytic Treatment. By Dr. H. W. Frink. Pp. xxiv+344. (London: Kegan Paul and Co., Ltd.) 21s. net.

Diary of Societies.

THURSDAY, NOVEMBER 24.

ROYAL SOCIETY, at 4.—Special General Meeting to consider the Annual Report of Council. At 4.30.—K. Sassa: (1) Observations on Reflex Responses to the Rhythmical Stimulation in the Frog. (2) The Effects of Constant Galvanic Currents upon the Mammalian Nerve-muscle and Reflex Preparations.—E. Ponder: The Hæmolytic Action of Sodium Glycholate.—Dorothy J. Lloyd and C. Mayes: The Titration Curve of Gelatine.—D. H. de Souza and J. A. Hewitt: Idio-Ventricular Periodicity.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. C. Hay-Murray: Phrenology as an Aid to Education.

INSTITUTION OF LOCOMOTIVE ENGINEERS (London) (at Caxton Hall), at 7.15.—A. E. Kyffin: Axleboxes and Hornblocks.

CONCRETE INSTITUTE, at 7.30.—E. F. Etchells: Presidential Address.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—Prof. F. J. Cheshire: Polarising Apparatus.

INTERNATIONAL COLLEGE OF CHROMATICS (at Caxton Hall), at 8.—Dr. A. C. D. Crommelin: Colour and the Stars.

CAMERA CLUB (at 17 John Street, W.C.2), at 8.15.—Miss Olive Eddis: A Colour Photography Trip in Canada.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—Discussion on Renal Function Tests.—*Short Opening Papers* by J. J. Everidge, J. S. Joly, J. B. Macalpine, Dr. MacLean and C. Nitch, Dr. M. Wallis and G. Ball. To be followed by Sir Cuthbert Wallace, Dr. L. Brown, F. Kidd, Dr. Marrack, G. E. Neligan, A. E. Webb-Johnson, and A. C. Morson.

SOCIETY OF ANTIQUARIES, at 8.30.

FRIDAY, NOVEMBER 25.

ROYAL SOCIETY OF ARTS (Dominion and Colonies and Indian Sections, Joint Meeting), at 4.30.—A. H. Ashbolt: An Imperial Airship Service.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—Discussion on Hygrometry.—Dr. E. Griffiths: Some Modified Forms of Hygrometers.—F. J. W. Whipple: The Theory of the Hair Hygrometer.—F. J. W. Whipple: The Rationale of Glaisher's System of Hygrometry.—Principal Skinner: The Wet and Dry Bulb Hygrometer.—W. Watts: Determination of the Proper Constant in Apjohn's Formula for Use in Aeroplanes.—H. G. Mayo and Prof. A. M. Tyndall: A New Form of Absorption Hygrometer.—Prof. A. M. Tyndall and Prof. A. P. Chattock: A Thermal Hygrometer. To be followed by Sir Napier Shaw, Sir Richard Glazebrook, W. B. Hardy, Dr. G. C. Simpson, R. Corless, W. J. Hall, Dr. J. S. Anderson, Dr. G. Barr, W. H. Withey, and Dr. G. W. C. Kaye.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section), at 5.—Miss Eva Morton: Report on a Fatal Case of Bullous Eruption.

ELECTRICAL POWER ENGINEERS' ASSOCIATION (Southern Division) (at Central Hall, Westminster), at 7.—A. W. Bennis: Some Notes on Boiler House Plant.

INSTITUTION OF PRODUCTION ENGINEERS (at Institution of Mechanical Engineers), at 7.30.—A. F. Guyler: Drawings and Production.

JUNIOR INSTITUTION OF ENGINEERS, at 8.—G. F. Shotter: Electromagnetic Instruments: Problems in their Design and Construction.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.—Dr. J. P. Kinloch: Metabolism in Fevers.

MONDAY, NOVEMBER 28.

INSTITUTE OF ACTUARIES, at 5.—S. J. Perry: The Relation between the Course of Wholesale Prices of Commodities and the Market Value of Various Classes of Securities.

ROYAL SOCIETY OF MEDICINE, at 5.—Dr. Guelpa: The Treatment of Diabetes and Gout by Disintoxication.

FARADAY SOCIETY (at Chemical Society), at 8.—J. N. Greenwood: The Effect of Cold Work on Commercial Cadmium.—J. N. Pring and E. O. Ransome: Reaction between Cathodic Hydrogen and Nitrogen at High Pressures.—F. H. Jeffery: The Electrolysis of Aqueous Solutions of Alkaline Nitrites with a Lead Anode, and an Electromagnetic Determination of the Constitution of the Complex Anion Formed.—T. C. Nugent: An Inhibition Period in the Separation of an Emulsion.—N. R. Dhar and N. N. Mittra: Induced Reactions and Negative Catalysis.—Dr. S. J. Lewis and Miss F. M. Wood: Exhibition and Description of a New Adjustable Thermostat for all Temperatures between 0° and 100° C.

ROYAL SOCIETY OF ARTS, at 8.—A. M. Hind: Processes of Engraving and Etching (Cantor Lecture) (1).

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—W. F. Broderick: The Endocrine Factor in the Production of Immunity or Susceptibility of the Teeth to Pain.—S. Mummery: A Case of Mandibular Sarcoma in an Infant.

TUESDAY, NOVEMBER 29.

ROYAL HORTICULTURAL SOCIETY, at 3.—Dr. A. B. Rendle: Plants of Interest in the Day's Exhibition.

MEDICAL OFFICERS OF SCHOOLS ASSOCIATION (at 11 Chandos Street, W.1), at 5.—R. C. Elmslie: Status of Physical Instructors in Schools.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—C. M. Williamson: Photography and Mechanics: Facts and Possibilities.

ROYAL ANTHROPOLOGICAL INSTITUTE (at Royal Society), at 8.30.—H. Balfour: The Archer's Bow in the Homeric Poems (Huxley Memorial Lecture).

WEDNESDAY, NOVEMBER 30.

ROYAL SOCIETY, at 4.—Anniversary.

ROYAL SOCIETY OF ARTS, at 8.—N. Heaton: The Preservation of Stone.

THURSDAY, DECEMBER 1.

LINNEAN SOCIETY OF LONDON, at 5.—Prof. W. N. Jones: Note on the Occurrence of Brachiomonas.—J. Burtt-Davy: The Distribution of Salix in South Africa.—Miller Christy: The Problem of the Pollination of the British Primulas.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Capt. G. de Havilland: Design of a Commercial Aeroplane.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—L. J. Steele and H. Martin: The Cye-arc Process of Automatic Electric Welding.

ROYAL MICROSCOPICAL SOCIETY (Metallurgical Section), at 7.30.—The Practical Application of Vertical Illuminators in the Determination of the Structure of Metals and Alloys and in Metallographical Research Generally. Exhibition of Various Types of Vertical Illuminators by C. W. Hawksley and P. Swift.

CHEMICAL SOCIETY, at 8.—R. Mond and A. Wallis: Some Researches on the Metallic Carbonyls.—R. Mond and A. Wallis: The Action of Nitric Oxide on the Metallic Carbonyls.

FRIDAY, DECEMBER 2.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Geophysical Discussion: The Geological Effects of the Cooling of the Earth.

JUNIOR INSTITUTION OF ENGINEERS (at Caxton Hall), at 8.—B. L. Ladkin: Notes on Maintenance of Electrical Accumulators.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 8.—M. O. Dell: Ideals and Methods in Picture Making.

SATURDAY, DECEMBER 3.

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.1), at 3.—Prof. G. S. Boulger: The Sundews: Their Kindred and Neighbours.

PUBLIC LECTURES.

(A number in brackets indicates the number of a lecture in a series.)

THURSDAY, NOVEMBER 24.

UNIVERSITY COLLEGE, at 2.30.—Miss M. A. Murray: Ancient Survivals in Modern Egypt.

UNIVERSITY COLLEGE, at 5.—Prof. J. E. G. De Montmorency: Feudalism in India (4).

BARNES HALL (1 Wimpole Street, W.1), at 5.15.—Prof. E. C. Van Leersum: Dietetics and Public Health (Chadwick Lecture).

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—W. Bateson: Recent Advances in Genetics (4).

KING'S COLLEGE, at 5.30.—H. W. Fitz-Simons: Bridge Construction (4).

FRIDAY, NOVEMBER 25.

UNIVERSITY COLLEGE, at 4.30.—Dr. J. C. Drummond: Nutrition (7).

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 5.—B. G. Goodhue and D. Barber: American Architecture.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Dr. J. D. Falconer: The Wonders of Geology (Swiney Lectures) (9).

UNIVERSITY COLLEGE, at 8.—Prof. G. Dawes Hicks: Our Knowledge of the Real World (4).

SATURDAY, NOVEMBER 26.

UNIVERSITY COLLEGE, at 10.30.—Prof. Karl Pearson: Fallacies (Lectures for Teachers).

MONDAY, NOVEMBER 28.

UNIVERSITY COLLEGE, at 5.—A. T. Walmisley: Geometry for Engineers.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Dr. J. D. Falconer: The Wonders of Geology (Swiney Lectures) (10).

KING'S COLLEGE, at 5.30.—H. Moore: Liquid Fuels (4).

TUESDAY, NOVEMBER 29.

KING'S COLLEGE, at 5.30.—Prof. H. Wildon Carr: The Modern Scientific Revolution and its Meaning for Philosophy (8); The Theory of Creative Evolution; Dr. W. Brown: Psychology and Psycho-therapy (7).

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 6.—R. Unwin: American Architecture and Town Planning.

WEDNESDAY, NOVEMBER 30.

UNIVERSITY COLLEGE, at 3.—Prof. E. G. Gardner: Nature in the *Divina Commedia* (3).

KING'S COLLEGE, at 4.30.—Dr. C. Da Fano: Histology of the Nervous System (8).

UNIVERSITY COLLEGE, at 5.—Prof. G. Elliot Smith: The Evolution of Man (2).

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Dr. J. D. Falconer: The Wonders of Geology (Swiney Lectures) (11).

THURSDAY, DECEMBER 1.

UNIVERSITY COLLEGE, at 5.—Prof. J. E. G. De Montmorency: Feudalism in Western China and in Africa (5).

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—W. Bateson: Recent Advances in Genetics (5).

FRIDAY, DECEMBER 2.

UNIVERSITY COLLEGE, at 4.30.—Dr. J. C. Drummond: Nutrition (8).

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Dr. J. D. Falconer: The Wonders of Geology (Swiney Lectures) (12).

UNIVERSITY COLLEGE, at 8.—Prof. G. Dawes Hicks: Our Knowledge of the Real World (5).

CONTENTS.

	PAGE
Britain's Food Supply Basis	393
Priestley in America. By Sir T. E. Thorpe, C.B., F.R.S.	394
The Actinomycetes. By Dr. W. B. Brierley	397
Emin Pasha's Last Collections. By Sir H. H. Johnston, G.C.M.G., K.C.B.	397
Our Bookshelf	398
Letters to the Editor:—	
Metaphysics and Materialism.—Dr. Norman R. Campbell; Prof. H. Wildon Carr	399
Hybridity and the Evolution of Species.—Prof. J. P. Lotsy; Prof. R. Ruggles Gates	400
Biological Terminology.—Sir G. Archdall Reid, K.B.E.	401
The Softening of Secondary X-rays.—S. J Plimpton	402
The Molecular Scattering of Light in Liquids and Solids.—Prof. C. V. Raman	402
The Tendency of Elongated Bodies to Set in the North and South Direction.—Col. E. H. Grove-Hills, C M.G., F.R.S.	403
Ophion luteus.—Dr. C. J. Gahan; R. Stenton	403
Sex-manifestation and Motion in Molluscs.—G. C. Robson	403
Sinistral *Limnaea peregra*.—Prof. A. E. Boycott, F.R.S.	403
Some Problems in Evolution. By Prof. Edwin S. Goodrich, F.R.S.	404
Mount Everest. By Lieut.-Col. H. H. Godwin-Austen, F.R.S.	409
Obituary:—	
Sir Charles Douglas Fox. By W. C. U.	412
Prof. A. S. Delépine. By R. T. H.	412
M. Henry Bourget. By A. C. D. C.	412
Notes	413
Our Astronomical Column:—	
The Leonid Meteor Shower	417
A New Suggestion to Explain Geological Climatic Changes	417
Star Catalogues	417
British Research on Tides	418
The Influence of Egypt on African Death Ceremonies	418
University and Educational Intelligence	419
Calendar of Scientific Pioneers	420
Societies and Academies	421
Books Received	422
Diary of Societies	423

NATURE

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A Proposed National Institute of Industrial Micro-biology.

IN no department of chemistry has greater progress been made during comparatively recent years than in biochemistry—the youngest and in some respects the most fascinating of the various branches into which chemical science has, for purposes of convenience, been partitioned. The beauty, the mystery, and the deep import of the phenomena with which biochemistry is concerned cannot fail to make a strong appeal to the scientific imagination, even at a time when brilliant and fundamental discoveries in other branches of chemistry are so insistently claiming our attention and exciting our admiration and wonder.

Even if familiarity does not necessarily breed contempt, it often has a strong tendency to beget indifference, and this, coupled with the fact that biochemical phenomena are not, as a rule, of an arresting or spectacular nature, probably accounts largely for the lack of interest shown by chemists in general for so many years in this field of chemical inquiry. It is, however, this very absence of all that is spectacular or suggestive of difficulty or effort that makes the biochemical or life-processes so wonderful and so worthy of our closest study.

When we compare the synthetical methods of our laboratories with those of Nature we cannot fail to be struck with the essential crudity of the former. Great as were the intellectual achievements involved in the synthesis of, say, indigo, alizarin, nicotine, or camphor, it is certain that those and many other natural compounds are manufactured by the plant in a much more efficient and less wasteful manner.

By a close study of the way in which living organisms perform their remarkable feats of building up and breaking down, organic chemists will, no doubt, be enabled in course of time to dispense very largely with their fusion pots and their autoclaves and to work more closely on the lines of the living cell, at any rate so far as the synthesis of naturally occurring compounds is concerned. To this end intensive study of the phenomena of colloidal chemistry and of the nature of enzyme action (including the function of "activators" and "accelerators") becomes of the highest moment. This aspect of the matter has recently received consideration in two important and very suggestive presidential addresses—that of Sir William Pope to the Society of Chemical Industry, in Montreal; and that of Dr. M. O. Forster to the chemistry section of the British Association, in Edinburgh. I may, perhaps, be permitted to point out that it also formed the *leit motif* of my recent Cantor lectures on "Micro-organisms and some of their Industrial Uses."

In the micro-organism as a living cell we have a chemical laboratory of the highest efficiency and of the most remarkable character, and could we but understand and imitate artificially the processes of synthesis and analysis which are so quietly and so regularly occurring in, say, a single cell of yeast, we should be not only within measurable distance of a new industrial organic chemistry, but also we should be a little nearer to an understanding of that greatest of all problems —the nature of life.

Whether, with the growth of chemical knowledge, the services of the living cell in connection with industrial operations will be ultimately dispensed with only the future can show, but certain it is that that time is still far distant. At present a number of important industries are more or less dependent on the activities of certain lowly organisms, and from the point of view of successful and efficient factory working alone, it is essential that we should possess a very thorough knowledge of the nature of those organisms and of the influence of environment on their chemical activities. From whatever point of view, therefore, we regard the study of industrial micro-biology, it is clear that its encouragement and development are of high national concern. Anyone who makes an unbiased survey of the work done in this domain in various parts of the world

cannot honestly feel satisfied with the contribution made by this country, especially when regard is had to our outstanding position as an industrial nation and to the immensity of our Empire and of our resources.

The disastrous indifference which we have for so long shown to the claims of scientific research appears now to be giving way to a feverish attempt to make up the leeway we have lost. It was in the hope that industrial micro-biology might participate in this new expenditure of energy that I was induced to make a special appeal for the foundation of a national institute in a paper read before the Society of Chemical Industry at the annual general meeting of the Society in July, 1919. At present the provision made for systematic instruction in industrial micro-biology, and for the study of the innumerable important problems on which it bears, is very inadequate, and there is not in this country nor, so far as I am aware, in the British Dominions, any institution devoted to a subject which is admittedly of such great technological importance. In connection with brewing and distilling, an immense amount of work has been, and is still being, done, but other industries in which micro-organisms play an important and even a predominant part have been left largely to take their chances, with—in some cases—the result that might easily have been predicted.

It is impossible, in the course of a short article such as this, to deal at any length with these various industries, or even to enumerate them all. I may, however, instance the manufacture of lactic and butyric acids, the wine, vinegar, and dairying industries, agriculture, baking, tanning, and the treatment of sewage, as among the more prominent. In addition to this the manufacture of enzyme preparations for many purposes is becoming daily of greater importance, and finally there is the question of the production of what may be termed synthetic food.

Assuming a national institute such as I have advocated to come into existence, it may be well to summarise very briefly the functions which it might usefully perform and the ground its activities might cover. The first and perhaps the most important object of a national institute would be to provide for the systematic prosecution of original research in connection with the above industries, and, in fact, with any industry in which micro-organisms or enzymes play an important part. That a great deal of very valuable work of this kind has been done and is now being done in this country is well known to all who are familiar with the subject, but the institutions in which this work is being carried out are scattered, and there can be no doubt that far better results could be obtained if the many closely related problems connected with the activity of organisms and of enzymes could be studied in a single institution adequately provided with all the necessary appliances and specimens, where the various workers in closely associated fields would have an opportunity of discussing their problems with one another.

In the next place the institute would serve as a centre for the specialised training of men intending to devote themselves to the teaching of micro-biology and biochemistry in our universities and technical schools, and also for the practical instruction of factory managers and other technical employés engaged in the various biological industries.

A further function which the proposed institute might fulfil would be that of providing breweries, distilleries, and other factories with any required organisms in pure culture and in sufficiently large quantities for industrial purposes. Facilities of this kind exist to some extent in France, and, I believe, to an even greater extent in Germany, but they are practically non-existent in this country.

Then again the institute would serve to house as complete a collection of industrial micro-organisms in pure culture as could be got together. Recently something in this direction has been done in the formation, by the Medical Research Council, of the national collection of type cultures at the Lister Institute, under the directorship of Dr. Ledingham, but although this and other similar collections will certainly be of considerable use, they cannot take the place of the much more exhaustive and complete collection which it would be one of the main functions of a national institute to accumulate.

I am aware that the labour involved in maintaining such a collection as I am indicating would be considerable, but it is of the routine kind, necessitating the employment merely of a few carefully trained laboratory attendants working under the supervision of the curator of the collection.

The institute would further serve as a central biochemical library. At the present time steps are being taken to form one large library devoted to chemical literature, and there is a very general feeling that all overlapping and unnecessary multi-

plication should be avoided. With this policy of concentration I am in the fullest agreement, but I think it will be generally admitted by all who know that the literature of the subject with which I am dealing is of a very highly specialised character; that it is, of course, more largely biological than chemical; and that many of the most important volumes and some even of the periodical journals are not, as a matter of fact, readily obtainable in any of our existing libraries. The general demand for certain works dealing with micro-biology is too small, and the books themselves are, perhaps, too costly and too highly specialised to appeal to the majority of the members of the library committees of our scientific societies.

Finally (and this would probably not be one of the least important of its functions) the proposed institute would serve as a central home for British micro-biological science and as the institute to which all workers in this field of natural knowledge, in every part of our Dominions, could apply for information, to which they could send rare specimens for identification or for investigation, and to which they could—subject to proper safeguards in the matter of priority—communicate any discovery of importance.

The subject, in its botanical aspects, is not one with which I can claim anything more than a very limited acquaintance, but I have some reason to believe that in our Colonies and overseas Dominions there are mycologists who would experience the advantage of such an institution, and who, while obtaining information themselves, might render great national service by contributing to our knowledge of the nature of many fungoid plant-diseases.

I am well aware of the admirable work in the domain of industrial micro-biology which is being done in a number of isolated institutions in this country, as well as in one or two well-known American colleges, in the Pasteur Institute in Paris, in the Institute for Fermentation Industries in Berlin, in the Carlsberg Laboratory in Copenhagen, and elsewhere. Each of these institutions, however, deals with this immense subject in certain of its aspects only, and, as compared with the scheme which I am advocating, they suffer from the great disadvantage that there is no co-ordination, and that, consequently, a combined attack on any of the big problems which are calling for solution is rendered very difficult, if not impossible. Among such problems I might instance the biochemical conversion of cellulose into fermentable sugar, from which industrial alcohol might be prepared on one hand, or synthetic foods on the other.

A few years before the outbreak of war the formation of a national institution somewhat on the lines I have suggested in this article was advocated by Paul Lindner, of the Institute for Fermentation Industries in Berlin. It need scarcely be said that the institute Lindner advocated would have had its home in Germany, and I feel strongly that it behoves us in this country to take steps to establish, on British soil, an institution which, although primarily intended to meet the needs of British workers, might ultimately receive the support of many of our American and Continental colleagues.

I know that one of the greatest difficulties, especially at the present time, in connection with the scheme will be that of obtaining sufficient money for the purpose. It seems to me, however, that a beginning might be made in a very modest manner. A large and expensive building would not, in the first instance, be necessary or even desirable, for in a matter of this kind much more would depend upon the selection of the right men than upon the size of the building or even upon the perfection of its equipment. Possibly some existing building, preferably in proximity to one of our university colleges, would be available. A very important point, however, is that it should be a *separate national institute*, and not a mere department of some existing teaching institution.

A. CHASTON CHAPMAN.

Currents of Mathematical Thought.

L'Idéal Scientifique des Mathématiciens: Dans l'Antiquité et dans les Temps Modernes. By Prof. Pierre Boutroux. (Nouvelle Collection scientifique.) Pp. 274. (Paris: Félix Alcan, 1920.) 8 francs net.

THE aim of this work has been carefully explained by the author, and the reader must continually bear that fact in mind. The book is not a history of mathematics; it is not an account of striking discoveries, or a criticism of mathematical methods, as such. It is an attempt, in the light of our present knowledge, to trace the principal currents of thought by which professional mathematicians during different periods have been consciously or unconsciously influenced. No hard-and-fast boundary lines have been laid down; it is merely for the sake of convenience

that the whole time considered has been divided into three successive stages. The first of these ends when the classical Greek methods had practically lost their prestige and fertility; the second when (at the end of the eighteenth century) the new methods introduced by Descartes, Newton, Leibniz, and Euler seemed to have reached in like manner the limit of their powers and to be incapable of suggesting really new and important fields of research.

Now that so much good work has been done on Greek mathematics we can realise with fair accuracy what ideas the Greek mathematician had of his subject. It included the arithmetic of whole numbers as well as geometry, and for the Pythagoreans at any rate the former branch was the most fundamental. By the time of Euclid the Greeks had a perfect theory of proportion, and a method of exhaustion capable of solving problems for which we now use integral calculus. In Apollonius's "Conics" we have numerous propositions which are so easily translated into a modern algebraical form that one is almost tempted to think that the Greeks anticipated Descartes' analytical method. This, however, is not the case; and in the same way it is a mistake to fancy that they had a theory of irrational numbers. The discovery of incommensurable quantities led to a theory of proportion applicable to them, but the ratio of two similar quantities was never regarded as a number even if one of the quantities was an exact multiple of the other. Computation and measurement as such did not form part of mathematics; limitations of construction, such as those of Euclid's "Elements," seem due to a mixture of æsthetic and philosophical considerations. Archimedes' tract "On Method" shows that the greatest Greek mathematicians did not disdain the use of mechanical considerations as an aid to mathematical research; but they never were contented with a mechanical proof, and always tried to replace it by one strictly mathematical in their sense of the term.

Coming now to the second period, Prof. Boutroux considers that the great innovation of the seventeenth century does not consist in the use of new methods such as the infinitesimal calculus, but rather in the development of the notion of "function," especially in the form of an infinite series. Few things are more interesting than the history of the mathematical term "function." For a long period all the functions actually considered were those expressible by power-series. Even these were discussed in what would now be called a scandalously superficial way. In spite of the fact that as early as the time of the Bernoullis the problem of vibrating strings led to a prolonged discussion as to the possible or proper representation of so-called "arbitrary" functions, the subject was left "wropped up in mystery": it was often tacitly assumed that a power-series representation, at least for some intervals, was always possible if only it could be found. Fourier's introduction of trigonometrical series and his bold application of them to physical problems gave a sort of electrical shock to the mathematical world, and the use of complex quantities was still regarded by the orthodox as a sort of juggling trick which led to correct results in a quite inscrutable way.

The beginning of the modern period may be conveniently marked by Abel's memoir on the binomial series; in this we have for the first time a correct and rigorous treatment of an analytical function. After this, in the hands of Riemann, Dirichlet and others the subject made great strides, and the vast subject of the classification of functions has been attacked with a gratifying measure of success.

In tracing the currents of mathematical thought the author has frequently to deal with controversial matters on which he cannot pretend to give more than a plausible opinion. Perhaps the most important of these depends on the definition of mathematics. In our own opinion it is best for the present not to attempt any formal definition of mathematics, but to be content with the international schedule on which the Royal Society Subject-Index is based. So long as it is agreed to include such things as the theory of groups on one hand, and abstract dynamics on the other, a formal definition is practically impossible. But there is one point on which a difference of opinion is both significant and important. Is mathematics a science in the true sense, or is it an organised method of a special type reducible almost entirely to a branch of symbolic logic? We are very glad to see that Prof. Boutroux emphatically adopts the former view. To him, as to us, mathematics proceeds from a body of indefinable data which it discusses by means of special methods peculiarly its own, while its general method is simply that of all scientific research. The school of which Mr. Bertrand Russell may be taken as a representative has performed a great service by its critical discussion of what we may call mathematical first principles; but few of its members, we fancy, would claim that it has contributed to mathematical theory. At any rate the great body of progressive mathematicians have refused to admit any such claim; and we may venture to suggest one reason for

their doing so, a reason which can be appreciated by anyone of a mathematical turn of mind. There are certain ideas, such as those of the shape and connectivity of surfaces, which are extremely difficult, if not impossible, to reduce to arithmetical terms. The plain man will, we think, continue to assert that his concept of the shape of a sphere or an anchor ring is as clear as any that he has, independently of any arithmetical considerations; and this although in these cases analytical equations of the surfaces can be found; the same thing is true, in even greater measure, of Möbius's one-sided surface and its deformations.

Whether the reader of this book agrees with all the author's conclusions or not, he cannot but be grateful for the careful arguments by which they are supported. The last word on the subject has not been said, and vigorous controversy about it may be confidently expected; but whatever the final conclusion may be, Prof. Boutroux's work is likely to be regarded as a valuable contribution to the philosophy of mathematics. G. B. M.

Science and the Community.

From a Modern University: Some Aims and Aspirations of Science. By Prof. A. Smithells. Pp. 124. (London: Oxford University Press, 1921.) 12*s.* 6*d.* net.

WHATEVER Prof. Smithells has to say on the aims of education and aspirations of science is always worthy of attention, because it represents the wisdom of experience and the deliberations of a well-balanced mind. We are glad, therefore, that seven addresses, delivered by him on various occasions from 1906 to 1914, are here brought together in book-form, and we hope they will be widely read, particularly by members of the general public. The sub-title is a better index to the contents of the volume than is the main title, for the whole of the addresses are concerned with the relation of science to the community through education, industry, and other practical and intellectual activities. They state clearly and with dignity what science stands for in modern life, and their message cannot reach too extended a circle.

Prof. Smithells has decided views upon the place of science in education, and the significance of university work to industrial progress. In common with most university teachers, he holds that a broad and sound general education, in which science occupies a rightful part, is the best foundation upon which to build a university course, but he goes farther and urges with convincing iteration that universities serve the best purposes of industry when they treasure men of genius working in them purely for the advancement of natural knowledge and unfettered with considerations as to whether the instruction or research is directly profitable to industry or trade. "If," he says, "the sole purpose of our new universities were to make industry and commerce more effective instruments of either personal or national wealth, you might indeed find men to staff them, but you would not find men who were worthy of their hire, and you would have nothing that had a just claim to the title of a university."

The new universities have, no doubt, had a difficulty in convincing the business world around them that their essential function is the extension of knowledge into new fields, and not necessarily the improvement of the trade of the district in which they are situated, but they have mostly done so with gratifying success; and even in the ancient universities of this kingdom an obscurantist attitude towards scientific inquiry is not unknown. It is true that the caskets of the past are filled with treasures of fact, thought, and performance, but all that can be done in the social sciences is to reveal these products of human genius and action with the object of using them as a store of wisdom and experience from which guidance to policy or conduct may be gained. The experimental sciences, however, are particularly concerned with the discovery of things and principles never before known, and not with merely reconstructing past history. When Galileo first turned his small telescope towards the three stars in the Belt of Orion and the six in the Sword he saw in the field of view eighty stars which had never previously been looked upon by human eyes, and every such scientific discovery represents a similar expansion of the empire of knowledge—a Rosetta stone for the interpretation, not of human documents, but of the works of the Maker of the Universe.

When this distinction between literary records and scientific revelation is understood, no objection need be raised to the limitation of the "humanities" to matters relating to human affairs and human nature generally, though historically and actually experimental philosophers may claim to be humanists with as much right as do men of letters and students of social sciences. Prof. Smithells himself certainly belongs to this category, for he is no narrow pedant, but a man of wide interests and wise vision, and in almost every address in the present volume the key-note is sounded of science as a noble pursuit and an ethical influence. So much attention is now given to material results of scientific research that it is refreshing to find a representative of a modern

university, which has to look for support largely to business men, proclaiming over and over again that science teaching is not to be justified by works alone, but by the spirit of intellectual expansion. Yet while Prof. Smithells advocates science for its own sake as a necessary part of the curriculum in all stages of study, he does not overlook the fact that many great developments have had their origin in efforts to solve purely practical problems; and he illustrates this in one address by a sketch of Pasteur's work. He is, however, strongly opposed to the control of university teaching by technology, and says frankly: "I consider technical universities to be an educational mistake and a national danger of the first magnitude."

The attitude towards knowledge represented by this remark is characteristic of Prof. Smithells, whose message may perhaps be expressed by the phrase: "Foster the spirit of science, and the rest shall be given unto you." This is the exhortation alike to an Indian audience, to gas engineers, to journalists, to students of home science and household economics, and to the Workers' Educational Association. It is the *motif* of the whole composition, and discerning ears will distinguish it above the din of the market-place and the clanging of industrial hammers, and be stimulated by it. The best teaching of art, or literature, or music, is that which promotes appreciation of what is highest in each of them, and the same is true of science, whether the best be the revelation of a law of Nature through disinterested research, the creation of a new industry through scientific discovery, or the mental attitude developed by training in scientific method. Modern civilisation is built upon science, and a knowledge of its foundations is therefore essential to all who have power to determine the shape of the superstructure, otherwise it may be destroyed by its own strength. Prof. Smithells pleads eloquently and with inspiring conviction on behalf of natural knowledge and its human significance, and the cause to which he has devoted most of his life will be decidedly benefited if his advocacy of it is widely read.

William Osler.

Counsels and Ideals: From the Writings of William Osler. Second edition. Pp. xxiv + 355. (London: Oxford University Press, 1921.) 8*s.* 6*d.* net.

IT would be difficult to overpraise Osler. He was heart and soul in love with life—a man most lovable, courteous, gracious, of unfailing sympathy, hopeful, generous. Toronto, Montreal, Baltimore, Oxford—these universities were the stages of his work for mankind: a great teacher, a good example to all of us, a foremost representative of the science and art of medicine. He came from America to England as Mr. Lowell came, as an Ambassador: and by his culture, his devotion to the humanities, and his admirable gift of speaking well and writing well, he delighted Oxford as Lowell delighted London. It was an unheard-of thing, that Oxford should get a Regius Professor of Medicine from Baltimore: but it was a grand success. He drew together, in his profession, so far as one man could, America and England. He came at the end of the Augustan Age in Oxford: and it was like home to him.

There can be no higher praise of his influences —and it is not too high—than to say that he exercised, in medicine, that secret of teaching which Ruskin exercised in painting and architecture; and it is worthy of note that his writings have a touch, and more than a touch, of Ruskin, both in thought and in style. Only, life was kinder and sunnier to him: Ruskin is tragedy: Osler went from one happiness to another.

The new edition of Dr. Camac's anthology, "Counsels and Ideals," is good as good can be —full of wisdom, learning, humour, practicality, and loving-kindness. Not all of us, in the medical profession, can ever expect to rise from the ranks. For some of us, here and there in Osler's writings, the ideals must appear to be above attainment, and the counsels to be counsels of perfection. We have not, and we never shall have, his advantages. Yet, as one turns the pages, what a treasury of sound advice is in them! For example:—

(1) "Often the best part of your work will have nothing to do with potions and powders, but with the exercise of an influence of the strong upon the weak, of the righteous upon the wicked, of the wise upon the foolish. To you, as the trusted family counsellor, the father will come with his anxieties, the mother with her hidden grief, the daughter with her trials, and the son with his follies. Fully one-third of the work you do will be entered in other books than yours."

(2) "From the day you begin practice, never under any circumstances listen to a tale told to the detriment of a brother practitioner; and when any dispute or trouble does arise, go frankly, ere sunset, and talk the matter over, in which way you may gain a brother and a friend. . . . It is the confounded tales of patients that so often set us by the ears. . . . There is only one safe rule—never listen to a patient who begins with a story about the carelessness and inefficiency of Dr. Blank. Shut him or her up with a snap, knowing

full well that the same tale may be told of you a few months later."

(3) "Intemperance in the quantity of food taken is almost the rule. Adults eat far too much."

(4) "Things medical and gruesome have a singular attraction for many people. . . . To talk of diseases is a sort of Arabian night's entertainment to which no discreet nurse will lend her talents."

For graver and more intimate converse with Osler's mind, we have this anthology as our companion—a book worth reading, worth buying.

Our Bookshelf.

The Position in Space of the Aurora Polaris, from Observations made at the Haldde Observatory, 1913-14. By L. Vegard and O. Krogness. (Geofysiske Publicationer, vol. 1, No. 1.) Pp. vii + 172 + plates. (Kristiania: A. W. Brøggers Boktrykkeri A/S, 1920.)

THIS is an elaborate account of observations made to determine the height of the aurora, by the method originally devised by Störmer, and used by him in 1910. The method consists in photographing the aurora simultaneously at two stations some miles apart, and determining its parallactic shift relative to the stars. In the present work the authors employed a base line of 12·5 kilometres, much larger than the base of only 4·5 kilometres used by Störmer in his first experiments.

The lowest height of the aurora is a question of long-standing controversy. Many of the older observers thought that it reached on occasion to the ground level, but Dr. Simpson's observations in the Antarctic led him to think that this was an illusion, and certainly it seems very improbable if the theories now current of the origin of the aurora in corpuscular rays are to stand. Störmer never found anything lower than about 40 kilometres, and the present work seems to indicate that the lowest values found by him were erroneous, the base line employed not being long enough for accuracy. Vegard and Krogness find the lower limit to range from 73 to 166 kilometres. They find an indication of two maxima in the height distribution curve, at 100 and 106 kilometres respectively, and incline strongly to believe that these are real, and due to the presence of two kinds of corpuscular rays.

The methods of measurement and reduction are set out in great detail, and a large number of photographs are reproduced. R.

Dairy Bacteriology. By Prof. Orla-Jensen. Translated from the second Danish edition, with Additions and Revisions. By P. S. Arup. Pp. xii + 180. (London: J. and A. Churchill, 1921.) 18*s.* net.

THIS book has already passed through two editions in Denmark, and is now translated into English. It will be found to present a useful summary of the subject for the dairy worker, giving him information that will be of value in his routine work, and will help him in coping with the troubles that periodically arise in dealing with farm products.

Milk fresh from healthy cows contains a few organisms derived mainly from the air, the udder, and the teats; these are nearly all micro-cocci and sarcina forms, most of which are without action on the milk, though a few acidify and peptonise it. Milk which has been less carefully handled is liable to contain a great variety of organisms—coli, aerogenes, and others from the dung; fluorescent bacteria from the water used for rinsing the pails; and others from the bedding, stable dust, etc. The American "certified milk" contains less than 10,000 of these organisms per c.c.; this keeps well. The author gives other figures for other samples, running up to hundreds of millions per c.c. There is a good account of milk preservation and treatment.

Mitteilungen der Naturforschenden Gesellschaft in Bern aus dem Jahre 1919. Pp. lxxv + 231 + Tafel 5. (Bern: K. J. Wyss Erben, 1920.)

THE scientific communications published in this volume are mainly of local interest. Prof. Ed. Fischer chronicles additions to the list of species in the flora of Berne which have been noted in the past ten years; a large number are aliens which have been introduced in various ways. The most important communication in point of length is by Werner Lüdi on "The Succession of Plant Associations," an ecological study of the vegetation of the Bernese Oberland, with special reference to the Lauterbrunnen valley. Dr. R. Stäger describes some myrmecological observations on the Belalp at more than 2000 metres elevation, in which he notes the distribution of the seeds of *Thesium alpinum* by two species of ant. E. Gäumann gives an account of the occurrence and area of distribution in Switzerland of the species of the parasitic fungus genus Peronospora, and there is also a paper on the etiology of the "grippe" by Dr. Sahli.

The Elements of Direct-current Electrical Engineering. By H. F. Trewman and G. E. Condliffe. Pp. vii + 219. (London: Sir Isaac Pitman and Sons, Ltd., 1921.) 7*s.* 6*d.* net.

THE object of this addition to the many electrical text-books is to bridge the gap between elementary handbooks and treatises on dynamo design. The general principles of induced currents and electromagnetism are briefly recapitulated, a few of the more common instruments are described, and the main features of the direct-current dynamo and motor are treated in a practical way. We are pleased that the authors have the courage to use the calculus in such an elementary work where it simplifies proofs, for, as they rightly point out, "it is essential to all students of engineering." The treatment is apt to be a little too sketchy for the second-year student for whom the work is intended, and future editions should remove such blemishes as "electric-motive force."

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Relativity and Materialism.

PROF. WILDON CARR has for a number of years been busily engaged in ringing the death-knell of materialism. I was therefore not a little surprised to read in NATURE (October 20) his statement that Einstein's theory was the "death-knell of materialism." I thought, from my previous acquaintance with Prof. Carr's writings, that Bergson, Croce, and others had already done all that was necessary in that direction. But no! Prof. Carr has resuscitated it for the express purpose of killing it once more. That unfortunate doctrine seems to exist mainly for the purpose of being periodically slaughtered by professors of metaphysics; and we are led to the conviction that materialism must have very singular properties to survive so many tragic executions.

Well, it does possess a property which must naturally appear singular to those steeped in metaphysics—it happens to be true. Scientific materialism, as now understood, does not profess to be a rounded or final system of philosophy: it is merely a name for a few general principles, laid down by science, and selected for emphasis on account of their high human significance. Science makes new knowledge; philosophy (rightly understood) does not; it simply collects together certain principles yielded by science, those principles being selected as having some bearing on the deep undying problems of most profound human interest.

Among the scientific principles thus selected and emphasised by materialism—and the only one among them still seriously controverted—is that which states that mind cannot exist apart from matter, or as I prefer to put it, that mind is a function of material organisms. Prof. Wildon Carr is of opinion that mind *can* and *does* exist apart from matter; and he is under the impression that this opinion is justified by the principle of relativity. So far as I can follow his argument, it amounts to this. Space and time are relative to the observer; therefore the existence of an observing mind must be antecedent to the existence of space and time. True; but space and time are not matter: they are not objective things; you cannot weigh them or touch them; they are part of the mental framework which we erect for our convenience in dealing with external nature. They are concepts; just as the number 10 is a concept; not a thing, but a framework into which things can be fitted. "For the concept of relative space-time systems the existence of mind is essential." Prof. Carr might with equal profundity have said that for the presence of dew the existence of water is essential. Dew is aqueous; a concept is mental; but let me inform Prof. Carr that neither one nor the other of these propositions gives the slightest qualm to any scientific materialist, nor have they the least relevance to the question whether or not mind depends upon matter. We are not concerned with "concepts," which, of course, imply the previous existence of mind, but with objective *things*.

Now Prof. Carr argues that the "space-time system," involved by relativity, is conditional on the existence of mind. Very well then. It follows that if mind were to be extinguished throughout the universe, the laws at present ascribed to the universe would cease to operate, or perhaps the universe itself would cease to exist. Now that is an altogether incredible proposition. If Prof. Carr's mind were to be extinguished, the laws of nature would still remain as they are. If everybody else's mind were also to be extinguished the laws of nature would be unaltered. "Concepts" would vanish no doubt; but the validity of the principle of relativity itself does not depend on the existence of a mind which can testify to it. Prof. Carr exhibits that incurable confusion between concepts and objects which is common to all those who think that metaphysics is a rival method of science in the making of new knowledge.

Relativity of space and time no more conflicts with scientific materialism than does relativity of motion. But it is idle to argue with sentiment, and it is with sentiment alone that we have to do—sentiment unsupported by a fragment of evidence, and asserting itself in flat contradiction to every principle of logic. As a mere statement of truth, materialism will always reign, as it has reigned now for centuries as the basis of scientific experiment. But on a show of hands it will always be in a minority; its reign is that of an uncrowned king. There exists a wide and universal human sentiment which loathes materialism. That sentiment comes out in many different forms: in the vulgar superstitions of the uneducated, in spiritualism, in metaphysical dissertation. They are but the same deep sentiment on different intellectual grades, but as false and rotten in the higher grades as they are in the lower. Everywhere it comes out: in physiology we find it as vitalism; among the public at large it supports religion, the most powerful single factor that has moulded the destinies of civilised humanity. Materialism must always be unpopular; that is why it is so often being killed. But it is true; that is why it never dies; that is why it never will die; unless, indeed, it is one day drowned in the floods of oily sentimentalism.

Two hundred and fifty years ago the world of physics was fermenting as it is now. Newton was introducing a revolution of thought, comparable to the revolution of the last twenty years. Then, as now, the sudden upsetting of old ideas had in some sense a demoralising effect. There seems a real danger that metaphysics may take root, for a brief period, amid the general disorganisation consequent upon the revolution. A spectator does sometimes see most of the game, and I trust it may not be considered presumptuous in a spectator to sound an old note of warning at a time when many insidious invasions of science are being attempted by metaphysics: "Physics, beware of Metaphysics."

November 18. HUGH ELLIOT.

Metallic Colouring of Beetles.

IN reference to Mr. Onslow's letter on this subject in NATURE of November 17, I may say that it requires some care to prepare specimens for the pressure test. The chitinous coat is thick, and is softer below than it is at the colour-producing surface. The inner layers should be removed so far as possible, and the test-piece (which should not exceed 1/50 in. in diameter) cut from the remaining part.

In my experience, when these conditions are attended to the colour vanishes under pressure, and

in many cases returns when the pressure is relieved. The appearance then suggests a lamp alternately extinguished and relit.

The same precautions as to the smallness of the test-pieces and the absence of a comparatively soft bed under the coloured layer have to be observed in the case of metallic feathers.

The colours of anilin films are not affected by pressure otherwise than by the optical contact between them and the upper quartz lens.

The same may be said of the colours of tempered steel, etc. A simple experiment is to heat a piece of polished steel and to remove by polishing a narrow band of the coloured part. Then form a series of Newton's rings, having this band as a diameter. It will be found that in the straw-yellow of the tempered part the rings are scarcely displaced as they cross the band. Further, it may be noticed that when any of the colours are gradually polished off the colour does not change as the thickness of the layer is reduced but merely becomes fainter.

From this it may be gathered that the colours of tempering are not due to interference, at any rate in the ordinary sense in which the word is used.

A. MALLOCK.

The Tendency of Elongated Bodies to Set in the North and South Direction.

THE letters of Sir Arthur Schuster and Col. E. H. Grove-Hills in NATURE of October 20 and November 24 under the above heading are interesting, as is also the article by Mr. W. D. Lambert in the *American Journal of Science* for September last, to which reference is made by the latter, but the extremely weak gravitational force dealt with cannot possibly have any appreciable effect on my apparatus, and is certainly quite inadequate to account for the results of experiments made with it. Indeed, I gather from some of Sir Arthur Schuster's remarks that he feels that this is the case. The force that I have found to exist is another altogether, as I am confident anyone who has watched the experiments under favourable conditions would admit.

Mr. Lambert in his article is referring to a suspended rod of 40 cm. length, weighted at both ends, and finds for this that the force was only 1/400,000th of a dyne or 1/400,000,000th of a gram. Now, what conceivable effect can such a force have on a vertically suspended circular ring or disc of the thinnest paper, or other light material, of only 3½ cm. diameter? And yet it is with these that some of the most decisive results of my experiments have been obtained. Under favourable conditions the N. and S. directive force acting on the disc is by no means insignificant, and, indeed, when the sky is clear, the barometer high and steady, and there is no wind, it is frequently strong enough, when the apparatus is placed on high level ground in the open, to cause the disc to come to rest in the true N. and S. direction in less than five minutes, or to oscillate fairly rapidly (about five seconds interval) a few degrees on either side of this line. Moreover, other conditions are inconsistent with any purely gravitational theory being the explanation. I have used both suspended discs and pointers floating on paraffin oil, and obtained about the same results from both; not that one gives the E. and W. direction and the other the N. and S. The only difference noticed was that the floating pointer took longer to come to the N. and S. line. Further, it is not necessarily the elongated diameter that turns N. and S., as Sir Arthur Schuster assumes. For instance, if a strip of aluminium about 1 in. wide is coiled round into the form of a ring and then flattened so that the sides almost touch each other, when suspended vertically the flat-surface sides turn N. and S., as in the case of the ordinary discs. Now, if these flat surfaces are pulled out so as to form a ring with the elongated horizontal diameter several times as long as the breadth of the strip, it is not this elongated diameter that turns N. and S., but the surface breadth of the strip as before. In fact, there is no alteration in the direction, but the surface sides of the aluminium strip take up the same direction as when they were flattened close together.

In rainy weather, or when the sky is clouded or the barometer is falling, no satisfactory results can be obtained, and the disc will then usually turn approximately towards the bearing of the thickest clouds. From repeated experiments it has been found that when the apparatus is placed in an iron bucket covered with an iron lid, the N. and S. directive force ceases to act upon the disc, although it may be fairly strong in the open at the same time. The force appears to be strongest in still, frosty weather, when the sky is clear, even though there may be some ground mist.

Since the apparatus was exhibited at the Royal Society's conversazione in May of last year many more experiments have been made by observers in different parts of the world, extending from Spitsbergen in latitude 80° N. to the top of the Cameroon Mountain (13,353 ft.) close to the equator, and from Canada and the United States to the Red Sea, all of which give much the same results that I and others have obtained in this country; so whatever may happen in other parts, there can be no doubt that over this wide area of the earth's surface this N. and S. directive force does exist. In one or two other cases the results have been indefinite, owing apparently to the observers having no proper apparatus or the weather conditions being unfavourable. It is perhaps too early yet to speak positively about the nature of this N. and S. directive force, but the conclusion I have come to is that, in the main, it must be electric, and is probably due to the earth rotating in an electric field.

E. A. REEVES.

Royal Geographical Society,
Kensington Gore, S.W.

Table for the Duration of Sunset.

THE subjoined table was made thus:—From Table VI. in the American Nautical Almanac, for each date and latitude indicated, the hour of sunset on the meridian of Greenwich is taken and corrected for equation of time, giving an hour-angle precise within 1m. or 15′ (as both local mean time and equation of time are rounded off to the nearest minute). From latitude, declination, and this hour-angle the semi-duration of sunset in arc minutes is computed by the differential formula,

$$(1)\quad dP_1 = \cos h\, dh / \cos\phi \cos\delta \sin P_1,$$

in which P_1 = hour-angle, h = altitude of sun's centre, ϕ = latitude, δ = declination, and dh = sun's semi-diameter. As the hour-angle found from the Nautical Almanac is for the end of sunset, it is corrected by subtracting this approximate semi-duration, and the final value in mean time seconds is found by

$$(2)\quad dP = 8 \cos h\, dh / \cos\phi \cos\delta \sin P,$$

in which all sines and cosines refer to mid-sunset,

declination and equation of time being constant within 1/10° or 1m.

For computing a very good 10-in. slide-rule was used, which gives results as good as the Almanac hour-angles will allow and good enough for rough comparison with observed durations. (In careful study of the effects of atmospheric changes on sunset duration one would compute each sunset separately, with exact hour-angles, formula (2), and four-place logarithms.) In copying, the slide-rule results are rounded off to whole seconds.

In a most unfavourable case, winter solstice and latitude N. 60°, 1921, assuming the data of Table VI., American Nautical Almanac (given on p. 156, 1922), the error of computing may be tested. Computing the hour-angles for the beginning and end of sunset by the sine formula for time sights with declination and equation of time for the moments, and six-place logarithms, they are 42° 15′ 16·4″ and 43° 59′ 14·4″; the local mean times corresponding are 2h. 47m. 37·0s. and 2h. 54m. 33·0s.; the duration of sunset is 6m. 56·0s.=416·0s.

The mean hour-angle is 43° 7′ 15·0″. Using this in the differential formula (2), four-place logarithms give 415·5+ s., slide-rule 415·0+ s.; so that the differential formula is in error by less than ½s., or less than ⅛ per cent.

By slide-rule computing the differential formula with the hour of Table VI., 2h. 54m., the hour-angle at end is 43° 45′, first approximate semi-duration 51·3′, final mid-sunset hour-angle 42° 53′+, final computed duration 417·5s. This is an error of 1·5s. The result for the corresponding date of 1922, given in the table following, 414s., differs on account of a slight difference in the equation of time.

For lower latitudes the error grows smaller, as sin P approaches 1 and becomes insensitive; *e.g.* for the same date in 1921 and N. 45° six-place logarithms give 221·5s., four-place 221·7+ s., and slide-rule 221·5s.

For latitudes and dates intermediate among those of the table, and for other longitudes, linear interpolation suffices about as well as it does for the hour of sunset in Table VI., except that the date intervals are much longer; sunrise durations may also be interpolated. While the dates are for 1922, the values given should be good, within their limits of error, in other years as well.

Examination of the table, or of a graph of the same, shows that during the year for any latitude there are two maxima about the solstices and two minima about the equinoxes. The maxima are sharper than the minima. In low latitudes the summer maximum is less than the winter, due to the smaller semi-diameter of the sun; but in high latitudes, beginning above N. 52°, this is reversed, due to the unsymmetrical and exaggerated effect of refraction, which makes the sines of summer solstice hour-angles less than those of the winter solstice. At the autumnal equinox the duration is somewhat less than at the vernal, due to less semi-diameter; this holds good for all latitudes where the term "sunset" has any meaning. Elevation above sea-level would have an effect like refraction.

Since even constant refraction may thus reverse the effects of changing semi-diameter, it is clear that varying refraction must have considerable effect on the duration of sunset. In studying this effect, which led to the construction of the table, it is best to obtain the hour-angle directly with a watch; for when the time-sight formula is used an assumption has to be made about refraction, and an error in this assumption may considerably affect the hour-angle and so the computed duration. Between the tropics this error is of less account than in higher latitudes, but it is eliminated by the use of a watch.

The Duration of Sunset (in Seconds), 1922.

Lat. N.		0°	10°	20°	30°	35°	40°	45°	50°	52°	54°	56°	58°	60°
Jan.	1	142	144	152	168	180	197	220	253	270	292	319	356	406
,,	15	140	142	150	165	177	192	213	243	258	277	300	328	367
Feb.	1	136	138	146	160	170	184	203	226	239	254	271	292	318
,,	15	133	135	142	155	164	176	193	214	225	237	251	267	287
Mar.	1	131	133	139	152	160	171	186	205	215	225	237	251	267
,,	15	129	131	137	149	157	168	182	201	209	219	231	243	258
April	1	129	131	137	149	158	169	182	202	210	221	232	245	261
,,	15	130	132	138	150	159	171	186	207	216	228	241	255	273
May	1	132	134	141	154	164	177	192	217	229	243	258	278	300
,,	15	134	136	144	158	169	183	203	230	244	261	281	306	338
June	1	136	139	146	163	174	192	212	244	262	283	309	345	394
,,	15	138	140	148	164	178	194	218	252	272	295	327	368	429
July	1	137	140	148	164	176	193	216	251	269	292	322	364	422
,,	15	136	138	145	161	173	188	209	242	258	278	304	337	383
Aug.	1	133	136	143	156	168	181	201	227	239	256	275	298	329
,,	15	131	133	140	153	162	175	191	214	226	238	254	272	294
Sept.	1	128	131	137	149	158	170	184	204	213	224	237	251	268
,,	15	128	130	136	148	156	167	181	199	208	218	229	242	257
Oct.	1	128	131	137	148	157	168	182	200	208	218	229	242	257
,,	15	130	132	139	151	159	171	186	205	214	225	237	251	267
Nov.	1	134	136	143	156	164	178	195	217	228	241	256	274	295
,,	15	137	139	146	159	171	185	204	230	243	259	277	300	329
Dec.	1	140	143	150	166	177	193	214	245	261	281	305	336	376
,,	15	142	144	152	168	181	197	220	254	271	293	322	359	411
Mar.	21	129	131	137	149	157	168	182	200	209	219	230	243	257
June	21	138	140	148	164	177	194	217	253	273	297	328	370	434
Sept.	23	128	130	136	148	156	167	181	199	207	217	229	241	254
Dec.	22	142	145	153	169	181	198	222	255	273	295	324	362	414

WILLARD J. FISHER.

49 Langdon Street, Cambridge, Mass.,
October 23.

Relativity: Particles Starting with the Velocity of Light.

I WISH to point out a peculiar property of the motion of a particle in the theory of relativity when the initial speed is that of light. The result is valid for both the special and the general theory of relativity, but for simplicity I shall consider here only the former case. We start, then, with the Minkowski formula, $ds^2=c^2dt^2-dx^2-dy^2-dz^2$ This vanishes for the motion of a light-pulse. The interval ds is imaginary when the velocity is greater than that of light, and is real when the velocity is less than that of light.

If the velocity v of the particle is always equal to c, then all the elementary intervals vanish, so that the length-interval between any two positions is always zero. If, however, the particle merely starts out with the velocity of light and then slows down, so that the acceleration is negative, the interval between the initial world-point P and any other world-point Q will not be zero, and we raise the following question: What is the ratio between the arc PQ and the chord PQ, or, rather, what is the limit of this ratio as Q approaches P? Here, of course, we mean that both arc and chord are measured by means of the interval formula. If we use ordinary Euclidean measurement, of course the limit of this ratio for real curves is always unity. For the Minkowski geometry it turns out that the limit is unity whenever the initial velocity is less than the velocity of light, but in the exceptional case we are now considering we find that the limit is actually different from unity, and, in spite of ordinary intuition, is actually less than unity.

Our precise theorem is as follows:—*If the initial velocity is that of light and the initial acceleration is not zero, then the limit of the arc to the chord is* $\frac{1}{2}\sqrt{2}$, *which is approximately* 0·94.

If the initial acceleration is zero, so that the velocity remains that of light for neighbouring points, then the limit may have any value.

That the limit of the arc to the chord is not always unity for curves in the Euclidean plane was first

pointed out by the present writer (Bulletin of the American Mathematical Society, vol. 20, 1914, pp. 524–31), but the exceptions there are all imaginary, for the slope of the curve at the initial point has to be equal to $\sqrt{-1}$. The result is that the limit then takes a discrete set of values. It has to be one of the numbers 0·94, 0·86, 0·80, 0·74, . . . ; the particular one depending on the contact of the curve with the minimal straight line at the given point. If there is no contact the value is unity, but if the contact is of order $k-1$, then the value is $\frac{2\sqrt{k}}{k+1}$.

For Euclidean space of three dimensions it comes out that the limit can take all real and complex values. The Minkowski space is four-dimensional, and here also continuous variation is possible; but the essential point is that on account of the *minus* signs in the interval formula the exceptional cases which were imaginary in the Euclidean geometry now become physically real. This does not mean, however, that experimental verification would be easy. Particles have been found in radio-emanations where the initial velocity is more than nine-tenths that of light, but as long as the velocity is actually less than that of light the limit we are dealing with is unity. As the velocity is increased the limit thus remains unity. It takes the exceptional value 0·94 only when the initial velocity is actually that of light. Therefore, as the initial speed is increased continuously up to c, the limit jumps suddenly from unity to 0·94. The limit of the limit equals 1, but the actual value attained equals 0·94. *Such a discontinuity is perhaps beyond the possibility of experimentation, but there is no doubt of its theoretical validity.*

If, instead of the Minkowski formula, we use the general Einstein relativity theory, we have a curved manifold of four dimensions instead of a flat manifold. The formulæ, involving the potentials g_{ik}, are much more complicated, but again we find exceptional values for the limit of the ratio of the arc to the chord whenever the initial velocity is that of light —that is, whenever the world-line is tangent to a null geodesic on the curved manifold representing the field of gravitation.

EDWARD KASNER.

Columbia University, New York, September 20.

The Softening of Secondary X-rays.

DR. A. H. COMPTON'S letter to NATURE of November 17, p. 366, on the softening of secondary X-rays directs further attention to a problem of very great importance. There is distinct evidence with these rays of a change of periodicity which varies with the angle of scattering. Such a variation is, perhaps, unique in physics, and no satisfactory explanation of the facts has been found. Let us consider the history of the case.

In 1913 (*Phil. Mag.*, vol. 26, p. 611) I stated that when homogeneous rays struck any target the scattered rays were softer (*i.e.* of lower frequency), and that this softening increased with the angle of scattering. This view was a deduction from experiments with a heterogeneous primary beam consisting of the γ-rays of radium. The experimental results were verified by Dr. Florance (*Phil. Mag.*, vol. 27, p. 225, 1914).

In 1919, working at University College with heterogeneous X-rays, I again found that the secondary rays were less penetrating than the primary. At the time I was not successful in obtaining a homogeneous primary beam of sufficient intensity, for such a beam can be obtained only by reflection from a crystal. Later on I was informed that Mr. S. J. Plimpton, on continuing the problem at University College, had found evidence which apparently showed that when the primary rays were homogeneous, the secondary rays were of the same frequency. Hence, in a paper to the Journal of the Franklin Institute (November, 1920), I endeavoured to account for the softening observed with heterogeneous X-rays by assuming them to consist of thin pulses, which became thicker and softer, and hence of smaller apparent frequency as the scattering angle increased. Plimpton published his results in the *Philosophical Magazine* for September, 1921.

The work of Compton (*Phil. Mag.*, vol. 41, p. 749, 1921, and *Phys. Rev.*, vol. 18, p. 96, 1921), however, confirms my original view, although it may perhaps be advisable to substitute the term "secondary rays" for "scattered rays." On working with homogeneous X-ray beams he finds the same change as when ordinary X-rays of corresponding penetrating power are used. Thus secondary X- or γ-rays, even when homogeneous, decrease in frequency as the angle of scattering increases, and this remarkable relation is independent of the scattering medium.

I have always looked on the secondary rays as scattered rays, because the theory of scattering first given by Sir Joseph Thomson ("Conduction of Electricity through Gases," 1906, p. 321), and since developed by other writers, accounts so well for the variation in intensity of the secondary radiation with angle of scattering, and also for the observed polarisation of the secondary radiation. This theory, however, in its present form does not account for the changes in periodicity referred to above.

Compton suggests that the greater part of the secondary radiation is fluorescent, *i.e.* that it is produced by the secondary β-rays which are always emitted when X- or γ-rays strike any substance, and that the change in periodicity can be accounted for by means of the Doppler principle. I believe that it can be proved that only a negligible portion of the secondary X-rays can be accounted for in this way, and hence that this suggestion does not help us out of our difficulties.

J. A. GRAY.

McGill University, Montreal, November 12.

University Relief for Central Europe and Russia.

I SHALL be grateful for space to bring before readers of NATURE the following facts concerning the activities of the Imperial War Relief Fund, Universities' Committee. This committee, which was created at an Inter-University Conference which met at University College, London, on July 7, 1920, at the invitation of Lord Robert Cecil, and under the auspices of the Imperial War Relief Fund, has set before it the aim of presenting to the British universities the appeal of the universities in the war-stricken areas of Europe.

During the first year of the existence of the Universities' Committee 32,000*l.* was raised in co-operation with every university in Great Britain and Ireland. The committee at the opening of this university year carefully considered the problem of the Central European universities at the present time, and decided that it would be absolutely necessary for us to maintain the relief work promoted by the committee in co-operation with universities all over the world throughout the coming year.

I may say briefly that the financial panic which has swept through Austria in particular during the

last month has threatened the very existence of many distinguished men in universities of that country.

The Universities' Committee has also taken on the further responsibility of endeavouring to raise funds for the relief of men of learning and students in Russia. In careful consultation with Dr. Nansen, the committee is establishing those links in Russia which shall ensure a wise distribution of the funds subscribed. Dr. Nansen has issued a personal appeal to the universities of the world to help to save from extinction the rapidly diminishing numbers of men in Russia who have been able to go through the ordeal of suffering to which many of them have been subjected during the past few years. May I appeal to readers of NATURE for their support of the work of the Universities' Committee?

Further detailed information, which for lack of space cannot be given here, Miss Iredale, the organising secretary, will always be glad to send on application to any reader.

In a letter to graduate members of the British universities on behalf of the men of learning of Austria an urgent appeal has been made over the following signatures of distinguished representatives of learning :—

William Bragg, Bryce, A. S. Eddington, Richard Gregory, Haldane of Cloan, Frederic G. Kenyon, Walter Lock, Donald Macalister, Charles J. Martin, Henry A. Miers, Gilbert Murray, E. Rutherford, M. E. Sadler, Arthur Schuster, Napier Shaw, A. E. Shipley, George Adam Smith, Ernest H. Starling, J. J. Thomson.

MAURICE DE BUNSEN,
Chairman, Universities' Committee.

Fishmongers' Hall, London Bridge, E.C.4,
November 21.

Ophion luteus.

I BEG to thank Dr. Gahan and Dr. Stenton for their notes on this insect in NATURE of November 24, p. 403. I am well aware of the importance of precision in recording the behaviour of any animal and any other natural phenomenon; wherefore I was specially careful to ascertain from the persons who had been stung by Ophion in my house whether the insects had received any provocation. In most of the cases brought to my notice (numbering three or four in each of the last five years) the person stung was asleep, and may semi-consciously have made some movement that irritated the fly. But in the case I mentioned as happening last August, the young lady was reading in bed and felt the sharp stab on her arm before she saw the fly.

Our experience of the results of the sting differs from that of M. R. du Buysson as quoted by Dr. Gahan; but, of course, individuals differ very much in susceptibility to poisonous stings. The persons stung in my house, so far as has been brought to my notice, were all young, except one lady more than forty years of age. In her case, as in the others, the sting was followed by a painful and peculiarly hard swelling which did not subside in less than twenty-four hours.

Dr. Stenton asks whether care was taken to identify the species of Ophion. I sent specimens for identification to both Dr. Gahan and Mr. J. M. Gordon, who concurred independently in pronouncing the fly to be *Ophion luteus*.

HERBERT MAXWELL.

Monreith, Whauphill, Wigtownshire, N.B.

The "Zoological Record."

THE *Zoological Record*, which was founded in 1864 by English zoologists, has been issued regularly ever since, and contains each year a complete bibliography of all publications connected with zoology. It is now the sole work of the kind, and is invaluable to all workers in every branch of zoology.

Previous to 1914 the *Zoological Record* formed part of the "International Catalogue of Scientific Literature," and was issued under the joint responsibility of the Royal Society and the Zoological Society. As the Royal Society found itself unable to proceed with the volumes of the "International Catalogue" after the issue for 1914, the Zoological Society has undertaken to prepare and issue the volumes for 1915–20 inclusive at its sole financial risk.

It is the wish of the Record Committee of the Zoological Society to continue the publication of this most useful work, but it is obvious that it cannot expect the society to undertake the heavy financial liability involved in publication, unless it receives reasonable support from working zoologists both at home and abroad.

I hope, therefore, that all working zoologists who agree with me that the suspension of the publication of the *Record* would have a most disastrous effect on the progress of zoology will either subscribe themselves, or will urge the librarians of the institutions with which they are connected to do so.

A prospectus and form of subscription either for the whole or separate divisions of the *Record* can be had on application to the Zoological Society.

W. L. SCLATER,
Editor, *Zoological Record*.

Zoological Society of London, London, N.W.8.

Reflection from Cylindrical Surfaces.

THE cone of light reflected from a cylindrical surface described by Mr. Shaxby in NATURE of November 17, p. 369, is discussed in Tait's elementary treatise on Light.

A related phenomenon, also mentioned in the same work, the explanation of which is readily deducible from the above, is of interest. I refer to the circle of light seen by reflection of a distant point source from a bundle of cylindrical surfaces. The surfaces may be of any form, the condition being that their generating lines must all be parallel to one another. The locus of points of reflection is then a conical surface containing the source, with its apex at the eye of the observer. The axis of the cone is parallel to the generating lines of the surfaces. When the line joining the eye to the source is parallel to these lines, the circle reduces to a point coinciding with the source; when at right angles, the circle becomes a great circle passing through the source.

An everyday illustration of this is to be seen in the reflection of a distant street-lamp by the closed roller shutters of a shop-window. The points of light reflected from the corrugations form an arc of a circle which if completed would pass through the lamp.

The circle of light seen when viewing a point source through certain crystals is evidently due to the same phenomenon, the crystals presumably being fibrous in structure or containing enclosures or cavities with cylindrical surfaces. Some years ago Prof. S. P. Thompson submitted some crystals having this property to a meeting of the Physical Society of London.

C. O. BARTRUM.

32 Willoughby Road, Hampstead,
November 22.

Science in Westminster Abbey.

By ENG.-COM. EDGAR C. SMITH, O.B.E., R.N.

THE ceremony of unveiling a memorial in Westminster Abbey to the memory of the late Lord Rayleigh, which was held yesterday, November 30, may perhaps lend interest to a short account of the memorials to men of science already there. These memorials are more numerous than is generally supposed. There are few branches of science unrepresented, and in some directions the scientific activity of the nation is faithfully reflected by the men either buried or commemorated within the Abbey walls. Though interments have taken place in the Abbey for many centuries, it is only within the last two hundred years or so that any man of science has been buried there. The earliest British representative of science commemorated is the young astronomer, Jeremiah Horrocks, who died in 1641, a year or two after he had watched the transit of Venus. Astronomy is further represented by Adams and Sir John Herschel, but it is rather surprising that none of the Astronomers Royal—Flamsteed, Halley, Bradley, Maskelyne, or Airy—is commemorated. Mathematics and physics can show memorials to Barrow, Newton, Spottiswoode, Thomas Young, Joule, Stokes, and Kelvin; geology is represented by Woodward, Buckland, and Lyell; chemistry by Sir Humphry Davy; while Darwin, Wallace, and Hooker are the three outstanding naturalists. Surgery, medicine, and engineering all have memorials of interest, and to some of these brief reference will be made.

The first man of science of note to be buried in the Abbey was Sir Robert Moray, who played a very important part in the foundation of the Royal Society, and held the office of president up to the time of its incorporation. His grave is in the south transept. In his younger days an officer in the French army, Moray was royalist to the core, and received his knighthood from Charles I. He was also a favourite with Charles II., and though it is said that he "had no stomach for public employment," he served his Sovereign in various capacities. Of him Wood said that he was "a renowned chymist, a great patron of the Rosicrucians, and an excellent mathematician," while Burnet pronounced him "the wisest and worthiest man of the age." Moray is among the first of many fellows of the Royal Society commemorated in the Abbey, and the first of several presidents buried there. It was he who proposed Hooke as curator to the society. He died suddenly, July 4, 1673, in his pavilion in the gardens of Whitehall, and his funeral was carried out at the expense of Charles II.

Two years later the Abbey witnessed the interment of Thomas Willis, who as a young bachelor of medicine at Oxford had taken part in the meetings of the philosophers at the lodgings of Wilkins, Petty, and Boyle. Like Moray, a staunch royalist, at the Restoration he was made Sedleian professor of natural philosophy in the place of the ejected Joshua Crofts. Afterwards he gained much celebrity as a London doctor, his fame being such that it was said "that never any physician before went before him or got more money yearly than he." His death took place in his house in St. Martin's Lane, November 11, 1675, and a week later he was buried beside his wife in the Abbey, "an honour which he well deserved on account of his anatomy of the brain and the discovery of saccharine diabetes." The cost of his funeral is given at 47*l*.

In 1677 the Abbey saw the burial of Isaac Barrow, the celebrated mathematician and divine. First to hold the Lucasian chair of mathematics at Cambridge, Barrow in 1669 had resigned in favour of his pupil, Newton, and during the last three years of his life was master of Trinity. He died on May 4, and was buried not far from Moray in the north transept—now known as Poets' Corner. "He had come," says Stanley, "as master after master had come, to the election of Westminster scholars, and was lodged in one of the canonical houses 'that had a little stair to it out of the cloisters' which made him call it 'a man's nest.' He was there struck with high fever and died from the opium which, by a custom contracted when at Constantinople, he administered to himself." Another account says he died "in a mean lodging at a saddler's near Charing Cross." Moray, Wallis, and Barrow appear to be the only men of science buried in the Abbey during the seventeenth century.

The majority of the graves and monuments to men of science are found in the nave and the north aisle. Best known of all is the monument to Newton in the screen of the choir. Of the long inscription upon it Johnson said: "Had only the name of Sir Isaac Newton been subjoined to the design upon the monument instead of a long detail of his discoveries, which no philosopher can want, and which none but a philosopher can understand, those by whose direction it was raised had done more honour both to him and themselves." The gravestone close by bears the words: "Hic dispositum est quod mortale fuit Isaaci Newtoni." Voltaire was at Newton's funeral, and afterwards wrote: "Newton was honoured as he deserved to be both in his lifetime and after his death. The chief men of the nation contended for the honour of bearing the pall at his funeral. Go into Westminster Abbey; admiration is not paid to the tombs of the kings, but to the monuments which the gratitude of the nation has erected to the greatest men who have contributed to its glory. Their statues are to be seen there like those of the Sophocles and the Platos at Athens, and I am convinced that the mere sight of these glorious monuments has stimulated more than one spirit, and has formed

more than one great man." It is from Voltaire we have the story of Newton and the apple. He was in England from 1726 to 1729, and he learned it from Newton's niece, Mrs. Conduitt.

Buried next to Newton is his great successor, Lord Kelvin, while a little farther towards the centre of the nave are the graves of Telford and Robert Stephenson. Thomas Telford, designer of the suspension bridge over the Menai Straits, engineer of the Caledonian Canal, first president of the Institution of Civil Engineers, "a fellow of infinite humour and of strong, enterprising mind," died at 24 Abingdon Street, Westminster, on September 2, 1834, and was buried in the Abbey on September 10. Twenty-five years later Robert Stephenson, at his own request, was buried beside him. Both are commemorated elsewhere in the Abbey, Telford by a statue, Stephenson by a window. Still nearer the centre of the nave, and not far from the spot hallowed to-day as the resting-place of the "Unknown Warrior," is the common grave of Thomas Tompion (1639–1713), "the father of English watch-making," and his successor, "honest George Graham" (1673–1751), who constructed astronomical instruments for Halley and Bradley, and "whose inventions do honour to ye British Genius, whose accurate performances are ye standard of mechanic skill." The present tombstone was removed in 1838, and for some years, until Dean Stanley replaced it, Graham's grave was marked only by a plain lozenge-shaped stone. At the west end of the nave is the memorial to John Conduitt (1688–1737), who married Newton's niece and succeeded him at the Mint. It is within Conduitt's monument that a tablet was placed some forty years ago to commemorate the brilliant work of the young Lancashire clergyman, Jeremiah Horrocks.

Of no less interest than the nave is the north aisle, the windows of which commemorate the work of Richard Trevithick (1771–1833), most fertile of inventors, and, like Hedley, Blenkinsop, and George Stephenson, one of the fathers of the locomotive; the younger Brunel (1806–59), who lived just long enough to see the completion of his greatest works, the Albert Bridge at Saltash, and the "Great Eastern"; Sir Benjamin Baker (1840–1907), joint engineer with Fowler of the Forth Bridge; Joseph Locke (1805–60), one of the greatest of railway engineers; Robert Stephenson (1803–59), constructor of the London to Birmingham railway, designer of many famous bridges, and, like Baker and Locke, president of the Institution of Civil Engineers; Lord Kelvin (1824–1907), the greatest of modern physicists, who redeemed the Atlantic cable from failure and showed the possibility of utilising the power of Niagara; and Sir William Siemens (1823–83), electrician and metallurgist, a pioneer of the dynamo, and the inventor of the regenerative furnace, and president of the Institution of Mechanical Engineers.

Beneath these windows are the monuments to John Woodward (1665–1728), professor of physic at Gresham College, founder of the chair of geology at Cambridge, and author of an "Essay towards a Natural History of the Earth"; the grave of, and monument to, Sir Charles Lyell (1797–1875), "the founder of English geology"; and near the spot where Ben Jonson was buried upright in a space 2 ft. by 2 ft.—all he asked for—is the grave of John Hunter (1728–93), the great anatomist. Originally buried in the vaults of St. Martin's-in-the-Fields, Hunter's coffin was brought to light by Frank Buckland as the result of a unique example of "chivalrous devotion to the relic of a great man." At the close of the afternoon service in the Abbey on March 28, 1859, in the presence of the president and fellows of the Royal College of Surgeons, Hunter's remains were re-interred among those of his peers. A little past the monument to Richard Mead (1673–1754), "prince of English physicians," who attended Newton in his last illness, and with whom Woodward fought a duel in the entrance to Gresham College, are found the graves of Darwin and of Sir John Herschel, "the prose poet of science," whose vow "to try and leave the world wiser than he found it" was amply fulfilled by a life full of the noblest effort.

Further to the east, just within the aisle of the choir, and grouped about the tomb of Lord John Thynne, fifty years a canon of Westminster, are the memorials to Adams, Stokes, Hooker, Wallace, Darwin, Lister, and Joule. Most of these memorials are portrait medallions, but that to Joule is a tablet, the inscription upon which states that it was erected "in recognition of services rendered to science in establishing the law of the conservation of energy and determining the mechanical equivalent of heat," achievements which, in the words of Tyndall at the Jubilee of 1887, formed "the largest flower in the garland which the science of the last fifty years is able to offer to the Queen." Mention must also be made of the statue close by of Sir Stamford Raffles (1781–1826), founder of the colony of Singapore and the first president of the Zoological Society.

Standing at the angle of the choir—now known as Science Corner—close to the grave of Darwin, with the graves of Newton and Kelvin to the south and the windows to the engineers to the north, in full view of the memorials of Darwin, Stokes, and Lister, it may be questioned whether there exists another spot which recalls such high endeavours, such lofty aims, such devotion to the search for truth and the spread of knowledge. The Abbey here is a veritable temple of science rivalling in interest the Statesmen's Aisle, the tombs of Plantagenets and Tudors, and even the Poets' Corner. Here are commemorated those whose guiding star was: "Prove all things; hold fast to that which is good." Here indeed are some to whom apply the words: "A wise man shall inherit glory among his people, and his name shall be perpetual."

The south aisle contains four monuments of scientific interest, the men commemorated being

Martin Folkes (1690–1754), president of the Royal Society for eleven years; John Freind (1675–1728), who while imprisoned in the Tower began his "History of Physic," and whose release was a condition laid down by Mead when prescribing for Sir Robert Walpole; Thomas Sprat (1635–1713), Bishop of Rochester and first historian of the Royal Society, who concluded his dedication to the King: "Your Majesty will certainly obtain immortal fame for having established a perpetual succession of inventors"; and William Buckland (1784–1856), the well-known Dean of Westminster and twice president of the Geological Society. In the early days of Buckland at Westminster his son, Frank, the discoverer of Hunter's coffin, climbed the roof of the nave and by means of a long pendulum suspended from it repeated Foucault's experiment for showing the rotation of the earth.

Besides the graves of Moray and Barrow already referred to, the south transept contains a monument to Stephen Hales (1677–1761), "pious, modest, indefatigable, and born for the discovery of truth," known to-day for his work on animal and vegetable physiology; and another to Sir John Pringle (1707–82), reformer of military medicine and the predecessor of Banks as president of the Royal Society. It was he who, when the world of science was torn asunder by the controversy over the pointed ends (Franklin's) and the blunted ends (Wilson's) of lightning conductors, made the reply to George III.: "Sire, I cannot reverse the laws and operations of Nature." Buried here is also Sir William Spottiswoode (1825–82), who died while president of the Royal Society.

Only a few more memorials remain to be noticed. Among these, however, is that of Watt. Of all the monuments within the Abbey none has called forth more criticism than Chantrey's great work which dominates the little chapel of St. Paul. "Well might the standard-bearer of Agincourt," wrote Stanley, "and the worthies of the Courts of Elizabeth and James have started from their graves in St. Paul's Chapel if they could have seen this colossal champion of a new plebeian art enter their aristocratic resting-place and take up his position in the centre of the little sanctuary, regardless of all proportion or style in all the surrounding objects. Yet when we consider what the vast figure represents, what class of interest before unknown, what revolutions in the whole actual framework of modern Society, equal to any that the Abbey walls have yet commemorated, there is surely a fitness in its very incongruity." Of Brougham's inscription Stanley said: "It is not unworthy of the omnigenous knowledge of him who wrote it or of the powerful intellect and vast discovery which it is intended to describe."

Watt's great contemporary, Telford, is commemorated by a statue in St. Andrew's Chapel, and here are also to be found the memorials to Matthew Baillie (1761–1823), pupil and successor of William Hunter, physician to George III., and president of the Royal College of Physicians; Sir Humphry Davy (1778–1829), discoverer of potassium and sodium, and inventor of the miner's safety lamp; Thomas Young (1773–1829), founder of physiological optics, and called by Rankine "the most clear-thinking and far-seeing mechanical philosopher" of his time; and lastly that to Sir James Young Simpson (1811–70), the great Edinburgh surgeon, by whose efforts "the fierce extremity of suffering has been steeped in the waters of forgetfulness." It is here, between the statues of Telford and of Mrs. Siddons, and above the memorials to Baillie and Davy, that the tablet to Lord Rayleigh has been placed. The chapel itself forms part of the aisle of the north transept, to which entrance is gained through the gates of the Ambulatory. Sir John Franklin, Admiral McClintock, who discovered the relics of the Franklin expedition, and Admiral Kempenfelt, all have their monuments here, while across the transept can be seen the window erected to the memory of the officers and men who were drowned in the Bay of Biscay through the capsizing of H.M.S. *Captain*, an eloquent reminder of the necessity of making adequate scientific research before embarking upon a great practical experiment.

The Nitrogen Problem.[1]

THE results of a detailed examination of the problem of nitrogen fixation were given in the comprehensive Final Report of the Nitrogen Products Committee of the Ministry of Munitions, published in 1920, and already noticed in these columns (vol. 104, pp. 533 and 569; vol. 105, p. 201). As the Ministry of Munitions is no longer in existence, the Department of Scientific and Industrial Research has arranged for the publication of the additional statistical information which has been accumulated since that time. This Supplementary Report has been drawn up by Dr. J. A. Harker, the director of the Nitrogen Research Laboratory under the Ministry of Munitions. It deals with the statistical aspect of the Chile nitrate industry, the saltpetre industry, the nitric acid industry, the ammonium sulphate industry, the synthetic ammonia industry, the Norwegian fixation industry, the cyanamide industry, the ammonia oxidation industry, and the fertiliser industry. It includes, in addition, a variety of miscellaneous statistics relating to the world's production of fixed nitrogen, national internal sources of fixed nitrogen, the world's fixation plants and power requirements, and the prices of nitrogen fertilisers in England and Germany. The whole concludes with a reference to the present position of nitrogen fixation in this country.

One of the most remarkable of post-war experi-

[1] Statistical Supplement to the Final Report of the Nitrogen Products Committee of the Ministry of Munitions. Department of Scientific and Industrial Research. (Published by H.M. Stationery Office, 1921.) 1s. net.

ences is to be seen in the widespread demand for fixed nitrogen products, especially in the form of fertilisers. In certain countries it is found that although the potential output has been greatly increased by the provision of large fixation plants during the period of the war, yet the total demand for fixed nitrogen is growing at an even greater rate. The same phenomenon is seen in the United Kingdom, which mainly relies upon imported Chile nitrate and home-made sulphate of ammonia. The consumption of nitrogenous fertilisers in 1919 was nearly two and a half times that in an average year before the war. The world's resources in nitrogen products have doubled during the last eight years. It is, however, to be remarked that while the percentage of the whole output contributed by the Chile nitrate industry decreased to one-half, the proportion contributed by the fixation industries has increased from 4½ per cent. of the whole in 1912 to 43 per cent. in 1920 —*i.e.* an increase in percentage of tenfold. The fixation industries are, in fact, now the largest contributors to the nitrogen requirements of the world. Cyanamide plant was largely extended during the war, and its present potential output is larger than that of any other fixation process.

The Supplement contains a series of tables dealing with the world's consumption of Chile nitrate during the war period, the total shipments and the British consumption during the same period, and the amount used for fertilisers and that allocated for war purposes. The figures, as might be expected, show violent fluctuations, due to a variety of causes, such as labour difficulties in Chile, shortage of coal, difficulties of transport, excessive freight charges, liquidation of war stocks, etc. The statistics are interesting, but as they are wholly abnormal it would serve no useful purpose to analyse them in detail.

As regards the saltpetre industry, it is noteworthy that whilst of the imports into the United Kingdom about two-thirds came from Germany, this during the war period was more than replaced by the growth of the Indian industry, which in 1916 attained more than six times its pre-war extent. In 1919 the supply from this source had declined to about one-third its maximum amount.

It need scarcely be said that the war had an enormous influence on the nitric acid industry. The annual pre-war production of nitric acid in this country was estimated at 15,000 tons of 100 per cent. acid, mainly for the manufacture of dyestuffs and explosives. The output in 1917 reached 237,000 tons, of which only 12,000 tons were used for other purposes than explosives.

The available information relating to the production of by-product ammonium sulphate is admittedly incomplete. During the war the market price, of course, steadily rose, and in 1919 the average price in the home market was nearly double that in 1914; the export price was 26*l.* 12*s.* 8*d.* f.o.b. U.K. ports. Germany, which heads the list of consumption, uses at the present time nearly double the amount consumed in the United Kingdom. In fact, she utilises nearly one-third of the world's consumption, mainly, of course, as a fertiliser.

As regards the synthetic ammonia industry, which is practically confined at present to Germany, it is estimated that the combined maximum output of the works at Oppau, and Merseburg when completed, will be about 1050 metric tons of ammonia per diem.

The Norwegian fixation industry has steadily developed since 1913. It is concerned with the synthetic production of the nitrates of calcium, ammonium and sodium, sodium nitrite, calcium cyanamide, and, intermittently, of nitric acid.

It is interesting to note that the general impression, sedulously cultivated by a certain section of German manufacturers, that the cyanamide industry is doomed is not borne out by the facts. There was a rapid extension of it during the period of the war, the world's production in 1917 being about three times that of 1914. Nine new works were erected in France, and the U.S. Government established in Alabama what is now the largest cyanamide factory in the world, with a capacity of about 200,000 tons of 20 per cent. cyanamide annually. As has already been stated, the cyanamide process is still the largest contributor to the world's nitrogen supply by fixation methods.

The ammonia oxidation industry practically owes its development to the war, due to Germany's imperative need for nitric nitrogen when her external supplies were cut off. Plants were also erected in America, France, Italy, and other countries, but complete statistics of production are not available. Details are given in the Supplement of the total annual output of two plants in Germany and two in America, amounting in the aggregate to 450,000 tons of 100 per cent. nitric acid.

An instructive table is given of the world's output of nitrogenous fertilisers, in metric tons, over the period 1910–18, for which complete statistics are alone available. The figures for Chile nitrate and by-product ammonium sulphate fluctuate, but, on the other hand, the synthetic products show a rapid increase, especially in synthetic ammonium sulphate, which is now practically equal to the by-product salt.

Col. White contributes certain statistical tables to the Supplement, one of which affords an approximate measure of the degree of economic independence of the several countries referred to as regards their internal sources of fixed nitrogen. Judged by this standard, Germany has four times the degree of economic independence of this country or of France, and six times that of the United States. Germany need no longer fear that even the most rigorous blockade will interfere with her supply of nitric nitrogen for munition purposes.

Tables are also given of the price of nitrogen

fertilisers in England and Germany, but as the economic conditions in the two countries were, and still are, wholly abnormal and scarcely comparable, it is not easy to determine their actual significance or to forecast their eventual importance.

In conclusion, reference is made to the attempts to develop nitrogen fixation in this country by Messrs. Brunner, Mond, and Co., who have taken over the projected Government factory at Billingham, and by Cumberland Coal Power and Chemicals, Ltd., who are to work the Claude process of synthetic ammonia.

The entire Report constitutes one of the most valuable lessons of the war, and deserves the most serious study. The subject of nitrogen fixation has not yet received the attention in this country which its great importance merits.

Obituary.

EMILE BOUTROUX.

THE death of Emile Boutroux at the age of seventy-six is the loss not only of one who has been for a generation a central figure in the circle of French philosophy, known everywhere in Europe and America, but also of one who by the charm of his personality seemed to embody all that is most attractive in the French genius. It will necessarily cast a gloom on the meeting of the Société Française de Philosophie which is to be held in Paris between Christmas and the New Year and to which English, American, and Italian philosophical societies are sending delegates, for he was to have been its président d'honneur. To those who have known him at former international philosophical congresses his loss will mean much more than his vacant chair.

The last years of Boutroux's life had been saddened by the loss of friends. He felt deeply the death of his brother-in-law, Henri Poincaré, in 1913 at the age of fifty-eight, cut off, as it seemed, in his full intellectual strength. In a conversation with the present writer a few years ago he remarked that his one dearest wish was to be able to show the fruitfulness of Poincaré's ideas in philosophy. In 1919 he lost his wife, who had been for many years his inseparable companion at home and in all his lecture tours in foreign countries. Yet with all the weight of sorrow and the increasing infirmities of old age (he suffered much from deafness and eye trouble) he retained to the end his extraordinary vivacity and charm of conversation and his power of sympathetic control when addressing a meeting.

Emile Boutroux represents a distinct and very important position in the history of contemporary philosophy, especially in relation to the modern scientific revolution. From his student days he devoted his attention to that conception of a universal determinism which, from the time of Descartes down to the great scientific development in the nineteenth century, had seemed to be the absolute and necessary basis of physical science. In 1874 he presented a thesis to the Sorbonne for his doctorate. It was entitled "De la Contingence des Lois de la Nature." For twenty years this book attracted little attention outside the circle of his students and philosophical colleagues. He was fully engaged in lecturing and teaching, and some of his lecture courses were published as studies in the history of philosophy. In 1895, however, at the urgent request of his friends, he republished his thesis in its original form, and since then it has gone through innumerable editions and has been translated into all the principal languages.

The main idea of the thesis Boutroux probably owed to his older contemporary, Lachelier, but the work itself is of striking originality. The argument is that nowhere, not even in the logical syllogism, do we get the type of necessity which is represented by the proposition of identity, A is A, and yet this and nothing short of this will satisfy the ideal of universal science. He went on to prove that the more we advance from the abstract to the concrete, from mathematics to physics, from physics to biology, from biology to psychology, the more we see the range of necessity being restricted and that of contingency growing larger. The suggestiveness of his theory rather than the systematic expression which he was able to give to it marks its importance. It places him in the direct line of that philosophical speculation which, starting with Maine de Biran in the beginning of the nineteenth century, may be traced through Ravaisson, Lachelier, and Boutroux himself to the present philosophers, Bergson, Le Roy, Blondel, and Laberthonière, all of whom were at one time his pupils.

H. W. C.

PROF. PETER THOMPSON.

PROF. PETER THOMPSON, whose untimely and deeply lamented death occurred at Penmaenmawr on November 16, early showed an unusual aptitude for human anatomy. He obtained a special mark of distinction in the subject when a student, and it gained him the gold medal on taking the M.D. (Victoria) from Owen's College, Manchester. He soon won a reputation as a brilliant and enthusiastic teacher after he was appointed senior demonstrator of anatomy at Owen's College. This reputation he fully maintained when he came to London, first as lecturer at the Middlesex Hospital, and later as professor of anatomy at King's College. In 1912 he was elected professor of anatomy and dean of the medical faculty of the University of Birmingham.

Prof. Thompson's contributions to the literature

of anatomy were numerous and valuable. His first, a monograph on the myology of the pelvic floor (1899), was in one sense his greatest. Not only does it give evidence of most painstaking, laborious, and exact work, but it sheds much light on one of the most complex myological problems to be found in the human body. At the instigation of Prof. (now Sir George) Thane, he spent the summer of 1906 in Prof. Wiedersheim's laboratory at the Anatomical Institute of the University of Freiburg, where he studied wax plate reconstruction under Prof. Keibel. Peter Thompson must be regarded as one of the pioneers in this country of wax plate reconstruction as applied to the human embryo, and his description of a 2·5 mm. human embryo of twenty-three paired somites, published in 1907, is now a classic. His whole-hearted enthusiasm and devotion to the new method of investigation infected not only his pupils, but also many colleagues and friends, much subsequent embryological work in this country being due primarily to his example and investigation. He was a most valued and assiduous member of the Anatomical Society of Great Britain and Ireland, serving in turn as secretary, treasurer, and vice-president, and contributing largely to its communications and discussions.

Prof. Thompson had the great gift of human sympathy in a wonderful degree, always took the keenest interest in the activities of others, and was greatly beloved by pupils and colleagues alike. His happy spirit and optimism never failed him even during the many dark days of illness, and his memory will be held precious by all who knew him.

WE regret to announce the death in Montreal on October 25 of SIR JOHN KENNEDY, consulting engineer of the Montreal Harbour Commissioners. From an account of his career which appears in the *Engineer* for November 11 it appears that he became blind in 1907, and at the time of his death he had reached the age of eighty-three years. The Institution of Civil Engineers elected him a member, and for some time he acted as a member of council. He was one of the founders of the Canadian Society of Civil Engineers, of which he was elected president in 1892.

Notes.

ON Thursday, November 24, Field-Marshal Earl Haig, who was accompanied by Lady Haig, unveiled memorials erected to the memory of members of the Institution of Mining and Metallurgy and the Institution of Mining Engineers who fell in the great war. The proceedings were opened by Mr. F. W. Harbord, president of the Institution of Mining and Metallurgy, and Col. W. C. Blackett, past-president of the Institution of Mining Engineers (in the absence of Sir John Cadman, the president). In the course of his address, Earl Haig expressed his satisfaction in having the opportunity to pay a personal tribute to a section of those many thousands of brave men who fought under his command, and to say a few words of special thanks to a body of men whose work in France seldom drew upon itself much notice or glory at the time, but was surpassed by none in the demands it made upon the skill, courage, and resolution of the individuals concerned, or in the service it rendered to the Army as a whole. He then referred in greater detail to the arduous and dangerous work accomplished by the Tunnelling Section of the Royal Engineers at Messines, on the Somme, and in other places, and concluded with an eloquent appeal for those who were left to learn the lessons taught by the men who had given the last full measure of their devotion to the cause they had so worthily upheld. The unveiling of the memorials was followed by a solemn silence of one minute's duration, after which Lord Haig pronounced the words: "Their name liveth for evermore," and the "Last Post" and "Reveille" were sounded. General Sir W. A. Liddell, Director of Fortifications and Works, and other distinguished generals and the officers and councils of the two institutions were present at the unveiling. The memorials are placed in the library at Cleveland House, 225 City Road, E.C.

MR. K. RASMUSSEN'S report of the progress of his expedition has reached Copenhagen. According to the *Times*, the expedition's vessel, the *Sea King*, did not reach the projected station at Lyon Inlet, in Melville Peninsula, until September 8, being delayed by heavy pack and engine trouble. A base was established on a small uncharted islet, named Danish Island, off Lyon Inlet. Mr. Rasmussen is well pleased with the situation as a centre for research, and reports plenty of bears, reindeer, and hares in the neighbourhood. Walrus and seals were seen daily in the sound. Ruins of Eskimo dwellings show that Danish Island was formerly inhabited. Mr. Rasmussen hopes to be able to trace the route of migration of the Eskimo through this region. When the report was dispatched he and a companion were setting out to visit the nearest tribes in the countryside, travelling by dog-sledge. The next report may be expected at the end of April, and will be sent *via* Fort Churchill and Winnipeg.

DR. E. N. MILES THOMAS has resigned the keepership of the Department of Botany of the National Museum of Wales.

A DISCUSSION on "Certain Geological Consequences of the Cooling of the Earth" will be held in the rooms of the Royal Astronomical Society on Friday, December 2, at 5 p.m. The chair will be taken by Sir Jethro Teall. Dr. H. Jeffreys will open the discussion, which will be continued by Dr. Jeans, Prof. Lindemann, Dr. Evans, and Col. E. H. Grove-Hills.

THE Royal Society of South Africa has elected the following officers for 1922:—*President:* Dr. J. D. F. Gilchrist. *Hon. Treasurer:* Dr. L. Crawford. *Hon. General Secretary:* Dr. W. A. Jolly. *Members of Council:* Sir Carruthers Beattie, Mr. S. H. Haughton, Mr. S. S. Hough, Dr. C. J. Juritz, Mr. C. P. Lounsbury, Prof. J. T. Morrison, Dr. A. Ogg, Dr. A. W. Rogers, and Dr. R. B. Young.

WE learn from *Science* that Dr. Harlow Shapley, formerly of the Mount Wilson Solar Observatory, has been appointed director of the Harvard College Observatory in succession to the late Edward C. Pickering, and that Dr. Joel Stebbings, director of the Washburn Observatory and professor of astronomy at the University of Wisconsin, is to succeed Prof. G. C. Comstock as director of the observatory in July next.

THE Trustees of the British Museum have decided to open the Natural History Museum to the public every Sunday from 2.30 p.m. to 6 p.m., commencing next Sunday, and on weekdays from 10 a.m. to 5 p.m. in the winter months, October to February, and from 10 a.m. to 6 p.m. in the summer months, March to September. Previously the hours of admission on Sundays have varied with the season of the year. The museum will be closed on Christmas Day.

LT.-COL. H. H. GODWIN-AUSTEN, Nore, Godalming, asks us to make known that a portfolio of his Indian sketches is missing from the rooms of the Royal Geographical Society, Kensington Gore, London, S.W.7, and he hopes that publicity will lead to its recovery. The portfolio is very large and heavy, about 2 ft. 4 in. by 1 ft. 6 in., strongly bound in black cloth. On the outside cover are set out the names of the countries the sketches were made in—Burma, Kashmir, etc.—the lettering cut out in gilt paper and pasted on. The portfolio contains about 160 sketches in water-colour, sepia, and pencil (a few loose), of which there is nearly a complete list made.

AT the meeting of the Sociological Society held on November 22, a lecture on "The Successors of Austria-Hungary: Some of their Problems" was delivered by Dr. R. W. Seton Watson. Mr. G. P. Gooch was in the chair, and his Excellency the Czecho-Slovak Minister was present, as well as representatives of the Rumanian and Jugo-Slav Legations. Dr. Seton Watson said that of all States Austria-Hungary had been the most complex, presenting not only a great diversity of languages and races, but also a peculiar divergence of culture. Its disappearance had been a unique event in history, similar only to the fall of the Roman Empire, caused, however, not by any general action of other States, but by slow political disintegration due to the lack of any underlying and unifying idea. Criticism of the Treaties of St. Germain and Trianon is easy, but clear-cut frontiers on ethnographical lines are unattainable, such is the intermixture of races. A complete political and social transformation is going on in Europe east of a line from Königsberg to Trieste, the chief, if not the only, citadel of reaction being Hungary. The lecturer went on to give a detailed account of the reforms developing in the succession States, paying a special tribute to the achievement of the Czecho-Slovak Government in the assignment of its various types of lands to the small holders and in education. In Jugo-Slavia, and in Rumania too, education is going forward. In all the succession States religion is becoming democratised and obscurantism has disappeared. We have here a vast laboratory of political, economic, and educational experiments.

MR. T. STEVENS, who laid down the hydraulic plant for the Niagara Power Station so long ago as 1887, gave a very interesting lecture on "Hydraulic Power Development" at Faraday House on November 22. He emphasised the fact that the large water-power undertakings at Niagara, Shawinigan Falls, Montana, etc., had all to wait ten or twelve years before they developed a paying load. In London experts had stated recently that we should build large power stations first, and then the load would be sure to come. Speaking as a hydro-electric engineer, he said that all his experience showed that such a procedure would be financially disastrous. He showed a strikingly beautiful photograph of the Shawinigan Falls enveloped in virgin forest and a recent photograph of the falls with not a tree left and surrounded by unlovely factories and houses. The town, however, has a flourishing population of 12,000, who have been attracted by the cheap power available. He also showed beautiful photographs of the Yguazu Falls, on the border line between Brazil and Argentina, which are among the largest falls in the world. Both the Yguazu Falls and the Victoria Falls on the Zambesi are situated in tropical countries, and the power available varies widely during the different seasons of the year. He pointed out that maximum power does not necessarily coincide with the maximum flow. For instance, a small fall near Yguazu had a 90-ft. drop and a good stream of water in the dry season. In the flood season the falls completely disappeared owing to the raising of the level of the lower part of the river. Owing to the great distances from the nearest centres of population of both the Yguazu and the Victoria Falls, he thought it most unlikely that they would attract an industrial population to their neighbourhood.

IN 1910 Major Patton came to the conclusion that the bed-bug is the invertebrate host of the parasite (the Leishman-Donovan body) of kala-azar, a disease of India and other tropical countries. Major Patton adduces further evidence in the *Indian Journal of Medical Research*, vol. 9, 1921, pp. 240, 252, and 255, in proof of this and Mrs. Helen Adie describes intracellular developmental forms of the parasite in the cells of the stomach of the bed-bug.

PROF. RAYMOND PEARL, in a paper in *Science* (vol. 53, p. 120, 1921), shows the exceedingly transitory effect of war, with its accompanying epidemic and other diseases, upon the rate of growth of population. In Vienna, for example, in spite of the distressing conditions which have prevailed there, it is probable that in 1920 the births will have exceeded the deaths. Prof. Pearl concludes that war and

devastating epidemics make the merest ephemeral flicker in the steady onward march of population growth.

IN recent papers, Marshall and Vassalls described a method of treatment of sleeping sickness which, they claimed, gives results better than any other (NATURE, vol. 107, p. 540). It consists in giving intra-venously a dose of neo-kharsivan, and afterwards withdrawing blood and injecting the serum into the spinal canal. In a critical review on the subject in the *Tropical Diseases Bull.*, vol. 18, 1921, p. 155, Dr. Warrington Yorke expresses the opinion that the theoretical grounds upon which the treatment is based are probably incorrect, that the treatment is not new, and that the results so far published fail to substantiate the claim that this treatment gives better results than other methods.

THE Ministry of Health has published as No. 9 of the series of Reports on Public Health and Medical Subjects (H.M. Stationery Office, 1921, 3*d.* net) a paper by Dr. J. M. Hamill entitled "Diet in Relation to Normal Nutrition." Dr. Hamill's object was to provide the general public with a straightforward account of the present state of knowledge. The study of nutrition involves a knowledge of highly technical matters, and it is difficult to present even the end results both clearly and truthfully to the mind of an untrained reader. Dr. Hamill has succeeded in combining intelligibility with veracity, and his report should be of great value to those who wish to know more of dietetics than just sufficient to provide material for chatter about vitamins. As so often happens, the daily Press has been responsible for evil as well as good in popular scientific education regarding nutrition. Recent discoveries in connection with accessory food factors have been so striking that the newspaper reader has perhaps rather lost sight of the more prosaic, but not less important, subject of energy values.

THE relationship of climate to disease has received more attention in popular talk, based on impressions and individual experiences, than from the exact inquiries of the medical statistician. There can be few places in this country that have not been at one time or another described as "bad for rheumatism" by some inhabitant. A paper by Dr. Matthew Young (*Journal of Hygiene*, vol. 20, p. 248) on the regional distribution of rheumatic fever is therefore all the more welcome. He shows that it is definitely more common, as judged by fatalities, in the north and west than in the midlands, east, and south of the British Isles, and finds substantial correlations, positive between the death-rate and the mean annual rainfall and negative between the death-rate and the mean annual temperature. The data are plainly open to the criticisms which can be made of any of the mass figures of the Registrar-General, but Dr. Young seems to have made out a strong case for an association between acute rheumatic infection, a high rainfall, and a low temperature. There are many things which show the same difference between the north-west and south-east in this country—*e.g.* many animals and plants, the relative abundance of oats and wheat in cereal crops—and one which is particularly relevant in questions of disease and scarcely susceptible of numerical expression is the general standard of civilisation.

NO definite instance of sexual differences in colour among Chelonia appears to have been clearly established. Considerable interest, therefore, attaches to the observations of Mr. S. F. Blake (Proceedings of the United States National Museum, vol. 59) on sixty specimens of the spotted turtle, *Clemmys guttata*, showing that this species possesses colour characters distinctive of each sex. The male has dusky jaws, no mandibular yellow-orange stripe, the throat but sparsely speckled with yellow, a slightly developed supra-auricular streak of yellow, and the crown of the head without spots. The female, on the other hand, has yellow jaws, a well-marked mandibular yellow-orange stripe, the throat densely spotted with yellow, a well-developed supra-auricular streak of yellow, and the crown of the head with several yellow spots. It is of special interest to learn that these sexual differences in colour can be detected clearly in very young specimens only a few weeks old.

THE director (Dr. E. J. Russell) and librarian (Miss Mary S. Aslin) have published "A Catalogue of Journals and Periodicals in the Library of the Rothamsted Experimental Station, Harpenden." The library began to develop in 1913, when the late Lady Gilbert presented the books and journals belonging to Sir Henry Gilbert. These were added to others previously given by Sir John Lawes. Expansion became possible through the support of many individual donors, learned societies, and Departments of Agriculture throughout the world. The library now contains most of the books and journals which the agricultural expert needs to consult. Though the library is not open to the general public, permission to use it for purposes of reference can be obtained on application to the director. The catalogue, which occupies 70 pages, is divided into sections according to subjects, the first and largest section dealing with agriculture, to which 50 pages are devoted. Other sections are devoted to animal husbandry, bacteriology, biology, botany, chemistry, education, entomology, forestry, horticulture and market-gardening, irrigation and reclamation, meteorology, general science, technology, and zoology. A large number of reports on special subjects are included in the catalogue, but no attempt is made to index individual papers contained in the regular journals. Names of authors do not, therefore, appear. The catalogue should be useful to those who are able from time to time to visit Rothamsted and use its library. It should also serve as an excellent guide to those who wish to get together a collection of authoritative reports on agriculture.

THE Kenya Department of Agriculture has published the meteorological records for 1920, the twelfth annual

report for the Colony and Protectorate. At the end of the year there were 21 stations observing temperature and rainfall and 180 stations observing only rain, making a total of 201 stations. The report mentions that the principal feature of the year was the abnormal rainfall experienced generally in November and December. Observations of atmospheric pressure are given for Mombasa, Nairobi, and Londiani; the range in the different months is small. Mean daily levels of Victoria Nyanza for morning and afternoon are given throughout the year 1920, and the average levels are given for each month and for the years 1904–20. There is a sheet of diagrams at the end of the report showing the normal rainfall, also the rainfall for 1920 and its difference from the normal, together with curves showing the monthly rainfall and the difference from the average at twenty-four representative stations. Monthly average rainfall tables for 126 stations are given for a number of years, the period varying from twenty-nine years at Mombasa and twenty-six years at Malindi to as short a time as two years at some stations; there are, however, forty-seven stations with observations for ten years and more. The yearly averages range from 95 in. at Meru (Eyembe Mission) to as little as 7·32 in. at the northern frontier (Wajir). The average monthly totals are generally largest in April and May.

In vol. 22 of the Special Reports on the Mineral Resources of Great Britain, one of the Memoirs of the Geological Survey, Mr. T. Eastwood describes the lead and zinc ores of the Lake District. This district, geologically considered, consists essentially of Cambrian and Ordovician rocks belonging to the Skiddaw and the Borrowdale series, interspersed with a number of igneous intrusions. These rocks are traversed by a number of fissure veins, in many cases accompanied also by faulting, and these veins have given rise to the mining industry here described. The chief gangue mineral is quartz, as might be expected from the character of the country, and galena and zinc blende constitute the minerals of economic value, the former being often rich in silver. The author gives a very full account of the various mines in the district dealt with, which is of great value to the student of British mineral deposits. Unfortunately the district is of no very great economic importance; even in normal times very few of the lodes described are rich enough to form the basis of a steady mining industry. At present, with the prevailing high price of labour, the relatively low prices of the metals extracted, and the high cost and difficulty of transport which further handicap most of them, none of these mines can be worked without loss.

The "Madruckverfahren," or machine-pressure process, is a new plan for the improvement of peat, so that this inferior fuel may be utilised as a substitute for lignite during the present coal scarcity in Germany. The Exhibition of Water-power and Energy in Munich opens up new perspectives by the publication of research material of the Gesellschaft für maschinelle Druckentwässerung in Uerdingen am Niederrhein. The process is based on the fact that the peat-colloid can be influenced if a finely divided additional substance is mixed with the raw peat. The material chosen is that available on the spot, namely, the partially dried peat with 30 per cent. of water. In this way a pressed product of 50 to 60 per cent. water-content is produced. This mixed product already shows a reduction of surface tension and a flocky and crumbly condition due to the particles of dry peat. Thenceforward the humus particles become the dispersion medium and water the dispersed phase. The reversibility in the earlier condition extends to a certain water-content, dried turf showing an irreversible alteration of condition. Ultimately the product is pressed into briquettes like lignite. These statements are extracted from an article by Heinrich Caro on "Veredelung minderwertige Brennstoffe nach dem Madruckverfahren" in *Die Naturwissenschaften* for September 16. The process may be valuable to Ireland, and even to England—a strange result of depriving Germany of coal.

Under the title "Utilisons la Houille Bleue," *La Nature* for October 29 contains an interesting article by M. H. Lémonon, illustrating a number of the earlier suggestions for developing tidal power by means of mechanisms operated by floats which rise and fall with the tide, or by air which is compressed into a suitable chamber by the rising tide. The article also describes a type of paddle motor in which motion of the paddles is derived from wave impact. While these are of historical interest, none of the methods outlined, nor indeed any such methods, are capable of utilisation on a large scale, and, generally speaking, their capital cost per horse-power of output would be so great as to render them commercially impracticable. The only hope of utilising tidal power on an economic basis would appear to lie in the use of tidal basins, storing water at high tide for use in turbines at periods between high and low tide, and in a following article the author intends to discuss such methods.

A dam may be constructed across a stream for any one of several purposes, such as city water supply, improvement of navigation, hydraulic power, or flood prevention. If suitably located and operated, a dam primarily intended to produce the head for a power scheme may also be utilised to improve the navigation above the dam, to store water for equalising the power output, for preventing floods, and at the same time improving the dry weather flow below the dam. This multiple effect cannot always be realised, but there are occasions when two or more of these functions may profitably be combined, and in an article in the *New Zealand Journal of Science and Technology*, vol. 4, No. 4, for August, 1921, Mr. A. D. Mead deals with the question of the most economical height of dam and the economic size of reservoir to satisfy the necessary requirements in a number of typical cases.

In a paper communicated to the Section of Physiology at a recent meeting of the British Medical Association, and briefly reproduced in the *British Medical*

Journal of October 29, Prof. M. C. Potter, of Newcastle, develops his previous researches in which he showed that the fermentation of cane-sugar by yeast develops an electromotive force. He urges that during the photosynthetical production of carbohydrates from CO_2 and water, electrical as well as thermal energy becomes latent, which is liberated again when the carbohydrate is decomposed, *e.g.* in muscular action, when the E.M.F. developed is proportional to the quantity of carbohydrate used. Similarly, from the fact that the carbon dioxide bubbling off from fermenting sugar is ionised, he proposes that the CO_2 coming from the tissues into the blood is in the same state. Measurements of the E.M.F. of the body as a whole gave very varying results.

ANODE rays produced by means of an anode composed of powdered carbon mixed with a halogen salt of the metal to be investigated, may, according to a paper by Mr. G. P. Thomson in the November issue of the *Philosophical Magazine*, be used successfully to determine the isotopes which are present in lithium, and to show that beryllium is apparently single, but they cannot be used to settle the question for the other alkali and alkaline earth elements. The method used is that in which an electrostatic field of the order of 1000 volts per cm., and a magnetic field of the order of 2000 gauss, act at right angles to the initial path of the anode rays, and produce parabolas on a photographic plate. These parabolas show that lithium consists of isotopes of atomic weights 6 and 7, but no trace is shown in any of the experiments of doubly charged or negatively charged metallic atoms. Parabolas due to the gas in the tube, *e.g.* carbon monoxide, water, fluorine, and iodine, were also detected and measured.

Nos. 1 and 2, for March and June last, of *Terrestrial Magnetism and Electricity* have been combined. Nearly half the combined issue is occupied by a paper by the editor, Dr. L. A. Bauer, on measurements of the electric and magnetic activity of the sun and the earth and interpretations. Various measures of solar activity based on areas of sun-spots, prominences, and faculæ are considered and illustrated graphically. Bidlingmaier's formula for the earth's magnetic activity is criticised adversely, and other measures proposed. The absolute daily range of the horizontal force finds most favour with Dr. Bauer. A deduction from observations made on board the surveying ship *Carnegie*, which if confirmed would be of fundamental importance, is that the diurnal variation of atmospheric electricity potential gradient at sea consists chiefly of a single wave, which progresses according to universal—not local—time, the minimum occurring about 4 a.m., the maximum about 7 p.m. Greenwich civil time. A second paper of considerable interest is an abstract in English of a memoir by Mr. L. Steiner, presented to the Hungarian Academy of Sciences in January last, discussing "a special form of magnetic disturbances" shown by the O'Gyalla magnetograms of the years 1906–17. These are of the "bay" type, but the changes in the several elements differ in phase, so that the force vector rotates. Steiner finds that the vector in the horizontal plane usually rotates clockwise in the morning hours and anti-clockwise in the afternoon. His results appear in general agreement with those derived some years ago from disturbances at Greenwich by Mr. R. B. Sangster, of whose work he seems unaware. There is a portrait and obituary notice of the late Dr. E. Leyst, of Moscow, a voluminous writer on terrestrial magnetism.

WE have received two recent issues of the Spanish popular scientific weekly *Ibérica*, which follows somewhat in its make-up the French *La Nature*. It contains scientific notes from Spanish and Latin-American sources and brief, interesting articles on general scientific subjects. The two issues before us contain a description of the radio-therapeutic laboratory at Granada University and of the biochemical section of the Faculty of Sciences at Saragossa; an account of the excavations carried out in 1920 at Aliseda (Cáceres) and the discovery of Phœnician relics; also a description of discoveries dating back to the Carthaginian age in Spain (at the Tutúgi necropolis), as well as interesting notes culled from foreign sources. This publication should form a valuable medium for the advertising of British scientific instruments and products in Spain and Portugal. The magazine is published in two editions (a cheap edition, and one on special laid paper), the address of the publishers being Apartado 9, Tortosa.

AT a meeting of the Newcomen Society held at Caxton Hall, Westminster, on November 16, a paper was read by Mr. C. F. Dendy-Marshall on "The Liverpool and Manchester Railway." Though built a few years later than the Stockton and Darlington Railway, the Liverpool and Manchester was the first considerable enterprise in railway engineering, and the date of its formal opening, September 15, 1830, may be regarded as the inauguration of the railway systems of the world. On that day eight trains left Liverpool drawn by eight of Stephenson's engines, among the drivers being George Stephenson, Robert Stephenson, Joseph Locke, Thomas Longridge Gooch, and Frederick Swanwick. The famous trial when Stephenson's "Rocket" beat the "Novelty," "Perseverance," and "Sans Pareil," had taken place a year before, October 6, 1829. Costing about 800,000*l.*, the line was thirty-one miles long and had a double track throughout. Just as Boulton and Watts's works at Birmingham became the training-ground of the early mechanical engineers, so the Liverpool and Manchester Railway was the school in which many of the greatest railway engineers gained their first experience. Mr. Dendy-Marshall not only gave much interesting information regarding the line, but he exhibited a fine collection of prints and illustrations, drawings, medals, china, etc., all of which added greatly to the interest of his paper.

WE have received from Messrs. Watson and Sons (Parker Street, Kingsway, W.C.2) their Bulletins Nos. 37 S and 40 S. The former gives particulars of the "Canny Ryall" portable diathermy apparatus.

It consists of a step-up transformer, condensers, spark-gap, and transformer, and is arranged to work off 100–200, and 200–240 volts alternating currents, with periodicities of 50–60. Bull. 40 S gives a list of second-hand electro-medical apparatus, including X-ray sets and accessories, all of which are guaranteed to be in first-rate working order, and show considerable reductions in price over similar new apparatus.

WE are indebted to a correspondent for the suggestion that the name of Dr. Henry Charlton Bastian, F.R.S., who died on November 17, 1915, should be added to the "Calendar of Scientific Pioneers." Bastian was not only a pioneer in neurology, but was also well known as a supporter of the doctrine of "heterogenesis," and for his investigations regarding the origin of life.

Our Astronomical Column.

THE DECEMBER METEORS.—Mr. W. F. Denning writes:—"This event is anticipated with unusual interest this year on account of the brilliant and abundant display observed in 1920. Early in the morning of December 13 meteors were observed to be falling at the rate of about five per minute, and several observers who were not regular meteoric students were attracted to watch the spectacle on account of its special character. The probability, therefore, that another rich return may take place this year renders it necessary that the sky should be attentively watched from about December 10 to December 13. The meteors are moderately swift and the radiant point is close to the star α Geminorum at the time of maximum, but, like the Perseids of August, the Geminids exhibit a radiant point which moves eastward at the rate of about 1° per day. The shower certainly begins early in December, if not late in November, but there appear to be few traces of it left after the middle of December.

"The Geminids have no cometary connection so far as we know, but it is highly probable that this system had its derivation from a comet which either belongs to a past, or the present, age, and probably having a long period of revolution."

THE ORIGIN OF COMETS.—The question whether the comets of long period belong to the solar system or are visitors from outside has been debated in recent years by many astronomers. Prof. G. Armellini contributes another paper on the subject to the September issue of *Scientia*. He points out the insufficiency for this purpose of the method of special perturbations, since this would have to be carried to an impracticable length before it could decide the character of an orbit at a great distance from the sun. Moreover, some who have used the method have failed to take the origin at the centre of gravity of the solar system, the result of this neglect being an apparent oscillation of the orbit from ellipse to hyperbola in a period of twelve years owing to the displacement of the sun by Jupiter.

Prof. Armellini introduces a new argument in favour of the origin of comets within the solar system, asserting that the combined attraction of the stellar system would tend to give closed orbits even to those comets the paths of which are hyperbolic while near the sun. The stellar attraction would be absolutely negligible in the region of space over which ordinary computations have extended, but might become sensible near the aphelia of the long-period comets. The author appears to assert that the stellar attraction would in all cases reinforce that of the sun; this, however, seems not to be the case. The resultant stellar action would evidently be very nearly constant both in magnitude and direction within the region of space in question; hence it would strengthen the sun's action on one side, but weaken it on the other. Unfortunately, our knowledge of the stellar masses is insufficient to form any estimate of the direction in which the resultant acts.

Prof. Armellini appears to make an illegitimate assumption in treating the stellar action as directly proportional to the distance from the centre of gravity of the star-sphere. This law would hold inside a homogeneous sphere, but not in a sphere where the empty regions enormously exceed those occupied by matter.

OBSERVATIONS OF MARS AT FLAGSTAFF.—The observations of Mars carried on for so many years at Flagstaff, Arizona, by the late Prof. Percival Lowell, are still being continued. This is fortunate, for the climate and the excellent 24-inch refractor by Alvan Clark are both well suited to the work. Bulletin No. 83 of the observatory describes the observations made in 1920 by G. H. Hamilton, and reproduces nine drawings made on dates between March 8 and May 26. These dates converted into the Martian Calendar (N. hemisphere), would correspond with July 8 and August 18.

The interesting feature of the opposition was the unusual number of white markings near the east and west limbs, which generally dispersed, or diminished in size, on the central meridian. As they appeared both over desert and dusky regions, and as the canals could be faintly seen through them, it is concluded that they were cloud or mist rather than ground frost. Even the Syrtis Major, usually so prominent, was sometimes almost lost in mist. From the fact that similar drawings were made in 1903 it is suggested that the phenomenon may occur at the same calendar date in each Martian year, but is clearly visible from the earth only once in fifteen years. Attention is also directed to the fact that these whitish areas are not surrounded by dusky borders, as they would be if the theory were true that explains the canals as the boundaries of regions of different tone, showing up more distinctly from the effect of contrast. The absence of the dusky border also supports the objective reality of the dark border round the polar cap.

It was also noted that some of the dusky regions looked unusually dark after they had been cloud-covered, suggesting growth of vegetation after rain. Altogether the observations support the view that there is more "weather" on Mars than has recently been thought probable. However, Mr. Hamilton quotes some similar observations made by Sir Norman Lockyer in the last century, from which Sir Norman concluded that the seasonal changes of Mars are very intense.

The Coming of Age of Long-distance Wireless Telegraphy and some of its Scientific Problems.[1]

IT is just twenty-one years since Senatore Marconi began to equip with wireless apparatus a station at Poldhu in Cornwall for the first attempt at trans-atlantic wireless telegraphy. Until then only appliances of a laboratory type had been used to signal to distances of about 100 miles. This first attempt at long-distance working necessitated the conversion of these appliances into engineering plant employing large power. Although at first the spark system, in which the electric waves are generated by discharges of large electric condensers, was used at Clifden in Ireland and Glace Bay in Nova Scotia, and developed by Senatore Marconi ultimately into the timed spark continuous wave system in the great wireless stations at Carnarvon, N. Wales, New Jersey, U.S.A., and Stavanger, Norway, the usual practice of late years has been to employ either the Poulsen electric arc generator, the high-frequency alternator, or, more recently, the thermionic valve generator. At the recently projected gigantic wireless stations, such as those at St. Assise, near Paris, and Long Island, U.S.A., the high-frequency alternators of Latour-Bathenod and of Alexanderson are to be employed. At the first Imperial wireless station at Leafield, Oxfordshire, erected by the General Post Office to correspond with one at Cairo, the Elwell-Poulsen arc generator is used. The arc generator has, however, the disadvantage that the waves emitted are a mixture of wave-lengths, and not a single pure wave or monochromatic. Important installations of large valve transmitters have recently been made by the Marconi Wireless Telegraph Company at Clifden, Ireland, and at their great Carnarvon station in N. Wales.

The length of waves mostly used for long-distance radio work is between 10,000 and 20,000 metres, or about 6 to 12 miles. It is possible from all large radio stations at the present time to communicate with their antipodes. So far as reception is concerned this long-distance working is entirely due to the thermionic valve, the first type of which was invented by Prof. Fleming in 1904.

It has been proved by the labours of many eminent mathematicians during the last twenty years, however, that the received signals at distances of 6000 to 12,000 miles are many thousands or even millions of times stronger than can be accounted for by pure diffraction or bending of the waves round the earth, and it is now fairly generally agreed that long-distance wireless telegraphy takes place only in consequence of the existence of an electrical conducting layer in the earth's atmosphere at a height probably of from 100 to 200 kilometres.

The presence of this highly conductive layer in the upper regions of the atmosphere, in which the component gases are hydrogen and helium, is probably due to electrified dust which comes to us from the sun being powerfully repelled against the attraction of gravitation by the pressure due to waves of light. This dust comes from the sun with enormous velocity and enters the higher levels of the atmosphere, rendering it an electric conductor. The conducting layer guides the radio waves round the earth and prevents them from escaping into space.

In addition, sunlight ionises the subjacent region during the day, but this is removed during the night. Vagrant natural electric waves are always being produced in the atmosphere, and are called "strays"; they are a serious nuisance in radio signalling at certain times, and especially in the tropics. The great outstanding problem of long-distance wireless telegraphy and telephony is the neutralisation of the effect of these vagrant waves on the receiving apparatus.

Prof. Fleming concluded with some remarks on the bearing on the theory of wireless telegraphy of recent physico-mathematical speculations on relativity, and especially the agnostic view now taken as regards the existence of a space-filling æther. It is clear that space is not a mere vacuum, but has remarkable powers of storing and transmitting energy, but modern physical and astronomical discoveries have rendered necessary great modification in our ideas regarding the structure of space or the æther, and no theory of radiation has yet been propounded which explains satisfactorily all the known facts. We are as yet unable to give any wholly satisfactory explanation as to the nature of the waves used in wireless telegraphy.

[1] Abridged from the fifth Henry Trueman Wood lecture at the Royal Society of Arts, delivered on Wednesday, November 23, by Prof. J. A. Fleming.

Physical Science at the British Association.

JUDGING by the continued interest displayed in the meetings of Section A during the recent visit of the British Association to Edinburgh, the proceedings of this section may be accurately described as very successful. Four strenuous mornings were devoted to the formal work of the section, yet the meeting-place was frequently overcrowded, and, even at the very end of the session, the audience numbered about eighty. There can be no doubt that the policy of the Association in encouraging joint discussions between the sections has met with general approval. Section A participated in two of these, both proving of absorbing interest. It is true that the time occupied by the joint meetings put a severe strain upon the rest of the sectional programme, which was undoubtedly too large, consisting of no fewer than twenty-nine items. This led to the necessity of adopting the somewhat undesirable practice of splitting up frequently into sub-sections; and the question of the limitation of the programme in future years is well worthy of consideration.

Some new departures were made by Section A at the Edinburgh meeting. The afternoon of the first day was made the occasion for demonstrations of novel physical experiments in the laboratories of the Natural Philosophy Department, where also apparatus of historical interest was exhibited. A semi-popular lecture was delivered on another afternoon. Both these new activities of the section met with great success, and ought certainly to be repeated at subsequent meetings. It may be hoped, too, that the excellent arrangements for producing a daily weather report (referred to later) will become a normal part of the work of Section A.

From remarks made earlier in reference to the lengthy programme, it will be understood that in the present report little more can be done than give a list of the papers and authors, with the addition of a few descriptive remarks in cases of outstanding interest. The proceedings opened on the morning of September 8 with a paper by Prof. J. C. McLennan on "Radiation and Absorption by Atoms with

Modified Systems of Extra-nuclear Electrons." The chief point of interest in this work is that by means of a suitable type of discharge it is possible to obtain from potassium two different spectra which correspond closely to the red and blue discharges in argon. Bearing in mind the fact that, according to present-day views of atomic structure, a potassium atom robbed of its valency electron has an outer electron configuration identical with that of argon, Prof. McLennan's results are explained if we suppose that it is electrons in this configuration which are responsible for the radiations he obtained.

Two papers were read by Prof. R. W. Wood, whom the section was fortunate enough to have present in the capacity of foreign guest. In the first of these, "The Time-interval between the Absorption and Emission of Light in Cases of Fluorescence," Prof. Wood described beautiful experiments with a new type of phosphoroscope (capable of recording to 1/400,000 second), which proved that mercury vapour illuminated by the flash of an aluminium spark remains non-luminous for about 1/15,000 second, and then bursts into a flash of green fluorescent light. Nothing but mercury vapour has as yet exhibited the phenomenon. The vapour must be *freshly formed* in order that it may fluoresce; metallic mercury must be present liberating nascent molecules. In his second paper, on "The Spectra of Hydrogen from Long Vacuum Tubes," Prof. Wood described how the use of very long discharge tubes enables the pure Balmer spectrum of hydrogen to be isolated from the continuous secondary spectrum, with the result that *twenty* lines of the series—as compared with thirty in the solar spectrum and but twelve in ordinary laboratory exhibits—can be recorded.

Another distinguished foreign guest, Prof. J. C. Kapteyn, read a paper entitled "First Attempt at a Theory of the Structure and Motion of the Stellar System." In this communication the author gave reasons for supposing that the stars, in the domain where the density exceeds one-hundredth part of the density near the sun, are distributed so that the surfaces of equal density are rotation ellipsoids all with their axes towards the pole of the Milky Way, and for treating them as in rotatory motion in two oppositely directed streams about this axis. By treating the whole system statistically according to the kinetic theory of gases, results are obtained regarding distribution which are in accordance with facts; and, for the region where star-streaming had originally been observed, the relative velocity of the streams calculated agrees almost perfectly with that observed.

Other papers presented during the morning were "Tubes of Force in Four-dimensional Physics," by Prof. E. T. Whittaker; "The Reception of Wireless Waves on a Shielded Frame Aerial," in which Mr. A. A. Campbell Swinton described experiments aiming, without success, at the construction of a unidirectional wireless receiver; and one entitled "Prehensility: A Factor of Gaseous Adsorption," by Prof. H. Briggs.

The afternoon was devoted to demonstrations and exhibitions. Dr. Carse had arranged an exhibit of historical apparatus, and members of the section also visited Prof. Whittaker's mathematical laboratory. Mr. J. J. Dowling gave a demonstration of a recording ultramicrometer, based upon the use of thermionic valves, Dr. W. L. Balls showed his simple harmonic analyser and periodoscope in operation, and Dr. Dawson Turner and Mr. D. M. R. Crombie made several experiments upon the behaviour of an electrified pith ball in an ionised atmosphere. The attendance throughout the afternoon was large.

On September 9 the first item on the programme was Prof. O. W. Richardson's illuminating presidential address on "Problems of Physics." The rest of the morning was devoted to a discussion, jointly with the Chemistry Section, on "The Structure of Molecules," already reported in NATURE of October 13 (p. 218).

More than two hours were spent on the morning of September 12 in discussing "The Quantum Theory." To Mr. C. G. Darwin fell the task of opening this discussion by outlining the theory and the experimental results which had necessitated its adoption. Sir Oliver Lodge communicated to the discussion two notes by Sir Joseph Larmor (afterwards published in the *Phil. Mag.* for October), entitled "Escapements and Quanta" and "Non-radiating Atoms." In the first it was suggested that perhaps atoms behaved like clocks, in that they possessed large stores of energy, not associated with periodicity, but released in quanta by the periodic orbital electrons. In the second note the author gave the conditions which must be fulfilled in order that, with close approximation, there should be no radiation from atoms having orbital electrons except when disturbed. Sir Oliver Lodge in his own contribution suggested that the cause of the change of orbit in the Bohr atom might be the absorption of a bombarding electron by the nucleus, thus reducing the atomic number by unity and necessitating the emission of energy during the establishment of the new stationary state. It was admitted that this view involved the transmutation of elements, but only to so small a degree that the percentage changed would be inaccessible of observation. Prof. J. W. Nicholson dealt with the question of stability in connection with permissible electron orbits in hydrogen and helium, and examined them from the point of view of magnetic properties and characteristic radiation. The connection between quanta and magnetic induction was explained by Dr. H. S. Allen, the results indicating the existence of discrete tubes of magnetic induction as suggested long ago by Faraday. Prof. W. Wilson gave a general mathematical account of the theory, and referred especially to Bohr's principle of analogy, which, although successfully applied to spectra in certain cases, should be regarded as only provisional in character. Some criticism was directed by Prof. J. C. McLennan at Sommerfeld's extension of Bohr's theory in connection with the fine structure of spectral lines. Prof. McLennan's experiments with the lines in the Balmer series of hydrogen did not indicate quantitative confirmation, such as had been claimed in the case of Paschen's work with helium. Dr. Irving Langmuir urged that the mechanism of the quantum theory should be sought for in the electron itself. He believed, for example, that the changes of orbit must be due to discontinuous changes occurring in the structure of the electron, and gave illustrations of what he described as the "quantum state" of the electron. Mr. C. G. Darwin replied to the discussion. Altogether, although of necessity somewhat disjointed, it proved of absorbing interest.

A paper was read by Prof. C. G. Barkla on "The Energy of X-radiation." In this the author explained the distinct properties of scattered X-radiation and fluorescent or characteristic radiation. In the former the laws of classical mechanics apply and all atoms contribute; in characteristic radiation quanta undoubtedly operate, and only a minute fraction of the atoms take part, these being in an abnormal state.

In the Mathematical Sub-Section three papers were

read, viz. by the Rev. J. Cullen in connection with prime numbers, by Dr. F. E. Hackett on a problem in relativity, and by Prof. D'Arcy Thompson on the properties of the tetrakaidekahedron.

In the afternoon Prof. A. S. Eddington delighted a very large audience with a semi-popular lecture on Einstein's theory of relativity.

On the last day of the sectional meetings (September 13) the chief business was the joint discussion with Sections C, D, and K on "The Age of the Earth," already reported separately in NATURE of October 13 (p. 217). There followed several papers of astronomical interest, including "The Microchronograph," by Prof. R. A. Sampson; "The Magnetic Storms of the Present Solar Cycle," by the Rev. A. L. Cortie; and "Discussion of the Radial Velocities of Stars," by Prof. G. Forbes. Earlier in the meeting also Sir Frank Dyson had given an account of the results obtained with the 72-in reflector in British Columbia.

As already mentioned, it was frequently necessary for a sub-section of cosmical physics to meet separately. In this sub-section Dr. A. Crichton Mitchell described the new geophysical observatory recently established in the Shetlands by the Meteorological Office, Air Ministry, for research on problems of terrestrial magnetism and electricity, and particularly work on aurora. Under the title "The Magnetic Anomaly in the District of Kursk, Russia" Prof. A. Kriloff gave an account of the unusually large observed variations of the magnetic elements in the region indicated. Capt. C. K. M. Douglas and Dr. H. Jeffreys, in papers entitled respectively "Some Remarks on Bjerknes's Theories of Cyclones and Anticyclones" and "The Cause of Cyclones," discussed the dynamical and physical conditions relating thereto. Mr. W. H. Dines, in some remarks on "The Discontinuity of Temperature at the Top of the Troposphere," suggested that it might be due to the very gradual sinking and spreading out in higher altitudes of air which had entered the stratosphere in tropical regions. Dr. Hans Pettersson read a paper on "Internal Movements in the Sea," in which he explained, and illustrated experimentally, the influence of the wind on the vertical displacements of strata of different salinity, temperature, density, and biological characteristics off the west coast of Sweden, together with the associated inflow of freshly saturated sea-water through the straits leading to the Baltic. In a paper on "The Dry Period of 1921 in England and Wales" Mr. M. de Carle Salter gave interesting statistics relating to the amount and distribution of rainfall during the recent drought.

An extensive exhibition of diagrams and photographs of meteorological interest, arranged in connection with the Edinburgh meeting of the Royal Meteorological Society, remained open for British Association members. In addition, Dr. Crichton Mitchell exhibited a series of autographic records from the Eskdalemuir Observatory, embracing magnetograms, electrograms, and Galitzin seismograms. Diagrams showing the diurnal variation of atmospheric pollution in normal conditions, during fog, and during the coal strike were shown by Dr. J. S. Owens.

During the meeting a branch of the Meteorological Office, Air Ministry, was established in connection with Section A in the Natural Philosophy Department of the University, and a wireless receiving set for the reception of data was specially installed there by the Communications Department of the Air Ministry. The programme outlined in NATURE of September 8 (p. 44) was carried out, and a daily weather report produced and exhibited in many public places in Edinburgh; while those visiting the rooms of Section A could see on a large blackboard the latest synoptic chart of the weather over an area extending from Spitsbergen southward to the North African coast and from the Azores and Iceland eastward to the Russian frontier. Meteorological and wireless officers were in attendance, who demonstrated to many inquirers the reception by wireless of the meteorological data issued several times daily by European countries, the subsequent charting, and the production of the weather report.

The Ethnology of the Sudan.

A THIRD ethnographical expedition, under the direction of Prof. C. G. Seligman, is being sent out by the Sudan Government with the object of investigating the tribes of the Mongalla province, particularly those along the east bank of the Nile. Prof. and Mrs. Seligman will be joined at Khartum by Mr. S. Hillelson, of the Gordon College. The peoples to be studied include the Bari, the Ascholi, the Madi, and the Latuka, and, if time permits, a trip into the old Lado enclave will be undertaken.

Scarcely any ethnographical information concerning the Latuka has been forthcoming since the time of Sir Samuel Baker (1821–1893), and little is known of them beyond the fact that they are ruled by their hereditary rain-makers, whose ceremonies for drawing down rain have been described. The Madi may be regarded as an entirely unexplored ethnic and cultural field.

The Ascholi are of especial interest, since they speak the Shilluk language, but are known not to share the Shilluk religion; indeed, they do not even know the name of Nyakang. Our knowledge of the Shilluk peoples is derived from the reports of the two previous expeditions undertaken for the Sudan Government by Prof. Seligman. In the winter of 1910 the inhabitants of the banks of the White Nile and the Nubas of southern Kordofan were visited, and in 1911–12 the desert Arabs in the region of the Kordofan-Darfur border and the Hammites of the Red Sea Province.

The Shilluks are a pastoral people numbering about 40,000 who live along the White Nile south of Fashoda and up the Sobat River. Their religion is chiefly king-worship. Their king is believed to be a reincarnation of the semi-divine founder of the dynasty, Nyakang, who is related to the great immanent creator Jŭok. Jŭok is worshipped only through Nyakang, who is the rain-giver of a land where irrigation is not practised. In his reports to the Sudan Government Prof. Seligman described the rain-making and harvest ceremonies of this people, as well as the process for transmitting the spirit of Nyakang to a new king. The reigning monarch is put to death on the first indication of failing powers, usually between the ages of forty and fifty, and a prince is chosen as his successor. The men of Akurwa bring from the shrine to the village of Kwom, near Fashoda, a sacred four-legged stool and an object bearing the name of Nyakang himself, which is believed to be a cylinder or a rude image. At Kwom the king-elect and his chiefs engage in a mock fight with the bearers, who are permitted to win, and escort the king to Fashoda. After a brief sojourn within the shrine the sacred stool

is placed on the ground outside and the mystic "Nyakang" set on it. The king-elect holds one leg of the stool and the highest chief holds another, while members of the royal family stand around. Certain men known as *ororo*, who are said to be descended from the third Shilluk king, kill and eat a bullock, and then place the king on the stool, while the image is taken in to the shrine. At sundown the king rises and is escorted to three newly built huts, where he remains in retirement for three days. During the fourth night he is quietly conducted to his palace, and on the following day gives public audience. The three huts are broken up and cast into the river. The men of Akurwa remain at Fashoda until the end of the dry season.

The divine spirit is thus not congenital, but must be conveyed to each successive monarch. The entry of a royal spirit into an individual is believed to be one of the commonest causes of sickness. Only the early kings take part in this, and they may be induced to leave the sufferer by sacrificial offerings at the appropriate shrine. Certain persons, the *ajuajo*, are regarded as permanently possessed, and these do a brisk trade in healing and the sale of amulets.

Fuel Research.[1]

THE first section, issued separately, of the report of the Fuel Research Board for the years 1920–21 is devoted to an account of experiments made at the Greenwich Experimental Station on steaming in vertical gas retorts. A Glover-West setting was employed, but the ordinary system of working was modified in one or two respects. The setting was fired by water-gas or coal-gas, the quantity of which could be measured, and the air for combustion was supplied under uniform positive pressure. Moreover, the air supply was preheated by the outgoing flue gases at the top of the setting in an exchanger built of steel pipes.

The work may be regarded as complementary to that carried out on the same subject at Uddingston by the Joint Research Committee of the University of Leeds and the Institution of Gas Engineers, and reported last year. It had the same aim of establishing trustworthy technical data for the process of steaming, which is increased in importance by the greater elasticity given to the manufacturers of gas by the provisions of the new Gas Act. Whereas, however, the work of the Research Committee at Uddingston was confined to one Scottish coal, tests have been made by the Fuel Research Board on several coals, including Consett and Mitchell Main gas nuts, although the coal used at Uddingston was included in order to bring the two sets of experiments into line.

This extension of the work to several coals has apparently made it impossible to secure the same construction of chemical balance sheets for carbon, nitrogen, and sulphur, which was a principal part of the work of the Research Committee. Data have been obtained for the increase in gas makes, the production of ammonia, and fuel consumption when operating with different quantities of steam, and as a result the favourable verdict of the Research Committee on the steaming process is confirmed.

A number of interesting tables and graphs, which will repay the critical attention of those specially interested, and a clear diagram of the train of plant which was employed for carbonisation and purification accompany the report. Some suggestions are given for consideration on practical points. One appendix deals with sampling, testing, and analysis, and three others with special points arising in the tests. The whole of the report is a full record of very extensive experimental work carried out on a subject which has been recognised by those associated with the gas industry as of a high order of importance. J. W. C.

[1] Department of Scientific and Industrial Research: Report of the Fuel Research Board for the Years 1920-21. First Section: "Steaming in Vertical Gas Retorts." (London: H.M.S.O., 1921.) 1s. 6d. net.

University and Educational Intelligence.

BRISTOL.—It has been decided to conform to the practice of most other English universities by granting a diploma (in lieu of a certificate) in engineering to students who, though not qualified for matriculation, pass the entrance examination for admission to the Faculty of Engineering and complete satisfactorily the course of study prescribed for this purpose.

Some years ago a committee was set up by the Faculty of Medicine for organising post-graduate studies for practitioners in and around Bristol, and during this autumn three courses of demonstrations have been given, two in Wiltshire and one in Dorsetshire. These have proved so successful that the committee is projecting a wider campaign, and is offering to arrange courses throughout the south-west of England. Each course consists of six demonstrations, one or more per week, and to each centre a large selection of subjects is offered from which those attending the course may select what seems to them of greatest value. In rural areas all the demonstrations are given by University lecturers, but in the large towns it is hoped to enlist the co-operation of the local hospital staffs. The demonstrations condense into small compass recent advances in the work of the medical profession, and each one is entrusted to a member of the Faculty who has given particular attention to that subject. In this form of University extension work Bristol leads the way so far as Britain is concerned, though we believe that similar work has been undertaken in Canada by the University of Toronto. It is as direct a return as any of the activities of the University for the grant now being made by local authorities.

LONDON.—The Senate has conferred the title of "Professor of Logic and Scientific Method in the University of London" on Dr. A. Wolf, former fellow of St. John's College, Cambridge, and fellow of University College, London. Prof. Wolf is the head of the Department of the History and Method of Science at University College and of Logic and Scientific Method at the London School of Economics and Political Science.

THE annual prize distribution and students' conversazione of the Northampton Polytechnic Institute, Clerkenwell, London, E.C., will be held on Friday, December 2. The Right Hon. Lord Southwark will distribute the prizes and certificates.

TRINITY COLLEGE, Cambridge, offers for the second time a research studentship of a value varying with the need of the student, but not exceeding 200*l.* a year, to a non-member of the University of Cambridge who proposes to enter that University in October, 1922, as a candidate for the degree of Ph.D. Applications should be sent as early as possible in

July next, and not later than July 25, to the Senior Tutor, who will supply further particulars on request.

At a meeting of the council of the Association of University Teachers, held on November 25 at Bedford College, Regent's Park, the following resolution was carried unanimously:—"That this council of the Association of University Teachers has heard with dismay the proposal of the Lords Commissioners of the Treasury to reduce the annual grant in aid of university education by 300,000*l.*, and protests against the proposal on the ground that it will seriously hamper the work of the universities, impair their efficiency, and in consequence retard their development in the future to the great loss of the nation." Prof. J. Strong, president of the association, stated that the present annual grant from the Treasury to the universities was about one-fifth of the total annual grant for education and one-thousandth part of the revenue of the country.

The calendar for 1921–22 of University College, London, provides a complete summary of the multifarious courses of instruction which are available during the present session at that college. Particulars are given of the teaching staff in each department, and by means of a series of reference numbers and letters a time-table has been constructed from which information can be obtained as to the exact lectures which students are advised to attend for the various courses suitable for London University degrees. The fellowships, scholarships, and prizes administered by the college are also recorded, together with the regulations affecting each. A number of appendices complete the volume, one of which is devoted to the Provost's report on the past session. As many as 3005 students were attending courses, a number which placed a heavy burden on the members of the teaching staff. In spite of this, however, a list of more than 280 original publications stands to their credit, showing that they still found time to make considerable contributions to the progress of knowledge.

The Board of Education has published (Rules 100, 1921, 2*d.*) particulars of a scheme in accordance with which arrangements have been made between the Board and the Institute of Chemistry for the award of national certificates in chemistry to students in technical schools and colleges in England and Wales. Under this scheme the institute, in conjunction with the Board, will approve schemes of training submitted by the technical schools or colleges for the award of certificates for part-time and full-time grouped courses, including, in addition to chemistry, suitable courses in physics, mathematics, and cognate subjects. Courses for part-time course certificates will be designated "Senior" for the ordinary certificate and "Advanced" for the higher certificate. Courses for full-time course certificates will be suitable for students who have attended a secondary school up to the age of sixteen years, and will include physics, mathematics, and one or more modern languages, and may include other cognate subjects. These certificates will be awarded in chemistry and in applied chemistry. Admission to the course in applied chemistry will be restricted to students who have satisfactorily completed a full-time course in chemistry or another course approved by the institute and by the Board. The training for the full-time course certificate in chemistry must extend over at least three years, while for that in applied chemistry at least one year will be required. The council of the institute will consider at a later date whether and how far the training and the higher certificates should be recognised as qualifying for admission to the examination for the associateship of the institute.

Calendar of Scientific Pioneers.

December 1, 1866. Sir George Everest died.—Entering the East India Company in 1806 as a cadet, Everest in 1823 succeeded Lambton as superintendent of the Trigonometrical Survey of India. Under his direction the measurement of the arc of meridian from Cape Comorin to the north of India was completed. His name was given to the great peak in the Himalayas.

December 2, 1897. Friedrich August Theodor Winnecke died.—Of Winnecke Gill remarked that he was unquestionably the greatest teacher of practical astronomy since the days of Bessel. From 1872 to 1882 he was director of the observatory at Strassburg.

December 3, 1920. Sir William de Wiveleslie Abney died.—Besides being prominent in all branches of photography, which he did much to develop, Abney did valuable work on spectroscopy, photometry, light, and vision. He served for twenty years in the Royal Engineers, and from 1884 occupied important positions in connection with public education at the Department of Science and Art and the Board of Education.

December 4, 1798. Luigi Galvani died.—While lecturer in anatomy in the University of Bologna, Galvani made many experiments in muscular contraction through electrical influence, and in 1791 published his "De Viribus Electricitatis. . . ."

December 4, 1893. John Tyndall died.—Commencing life as a railway engineer, Tyndall, in 1853, at the age of thirty-three, became professor of natural philosophy at the Royal Institution, a post he held until 1887. Like Huxley a fearless champion of freedom of thought, he was widely known for his work on diathermancy, diamagnetism, and the flow of glaciers, his lectures, and his books, among which was "Heat, a Mode of Motion," while as a mountaineer he was the first to ascend the Weisshorn.

December 5, 1859. Louis Poinsot died.—A student, professor, and examiner of the Ecole Polytechnique, Poinsot, in 1803 published his "Eléments de Statique," which contained his theory of couples, and in 1834 his "Théorie nouvelle de la rotation des corps," dealing with the motion of a rigid body.

December 5, 1902. Johannes Wislicenus died.—The successor of Strecker at Wurzburg, and of Kolbe at Leipzig, Wislicenus devoted himself to organic chemistry, and did pioneer work in stereochemistry.

December 6, 1771. Giovanni Battista Morgagni died.—The founder of pathological anatomy, Morgagni was a professor at Padua. In 1761, in his eightieth year, he published the result of his life's work, "Anatomical Researches into the Seats and Causes of Disease."

December 6, 1799. Joseph Black died.—Called by Fourcroy "the Nestor of the chemistry of the eighteenth century," Black made his two great discoveries of carbonic acid and latent heat in 1754 and 1761 respectively, and to him is due the principle of specific heats. As a student he was much influenced by Cullen, whom he succeeded in the chairs of chemistry at Glasgow and at Edinburgh. The date of his death is often given erroneously as November 10 or November 26.

December 7, 1912. Sir George Howard Darwin died.—The second son of the great naturalist, Darwin, from 1883, was Plumian professor of astronomy and experimental philosophy at Cambridge. His principal researches related to gravitational and tidal problems, and the stability of planetary orbits. He was knighted in 1905, and in 1911 received the Copley medal of the Royal Society. E. C. S.

Societies and Academies.

LONDON.

Geological Society, November 9.—Mr. R. D. Oldham, president, in the chair.—L. D. **Stamp** and S. W. **Wooldridge**: The igneous and associated rocks of Llanwrtyd (Brecon). Pt. 1: Stratigraphical (L. D. S.). The succession of rocks is given; the fossils from the lower horizon include *Dicranograptus rectus*, Hopkinson, *Glyptograptus teretiusculus*, var. *siccatus*, Elles and Wood, and *Climacograptus schärenbergi*, Lapworth; those from the higher horizon include *Dicellograptus sextans*, Hall, and var. *exilis*, Elles and Wood, and *Glyptograptus teretiusculus*, var. *siccatus*, Elles and Wood. Both assemblages are characteristic of the Dicranograptus shales of South Wales. The volcanic rocks of Llanwrtyd are therefore of lowest Bala (Survey classification) and on the same horizon as the upper basic and upper acid series of Cader Idris. The igneous rocks are cut off on the west by a fault, into which an intrusive mass appears to have been forced. Pt. 2: Petrographical (S. W. W.). The Lower Ashes are an acid series, of which the most characteristic member is a coarse flinty breccia. The spilites show pillow-structure in the upper part, but pass down into massive, finely vesicular rocks. The spilites are locally associated with spilite-breccias, consisting of angular fragments of various rocks and rounded bombs, of all sizes, of spilitic material. The bands of fine ash frequently interbedded with the sediments form dark flinty rocks weathering white. The intrusion is an enstatite-bearing rock of doubtful affinities.—L. D. **Stamp**: The base of the Devonian, with special reference to the Welsh borderland. The Ludlow Bone-bed forms a natural base: it consists of fish remains, all of which first appear at this horizon, and are genetically connected with higher Devonian faunas; it passes laterally into a conglomerate, and thus forms a natural physical base; it marks a palæontological and lithological break which can be correlated all over north-western Europe. The fauna of the lower beds (Ludlow Bone-bed, Downton-Castle Sandstone, and Platyschisma Shales) falls into three groups:—(*a*) Upper Ludlovian marine species which survived the change of conditions indicated by the bone-bed, but gradually died out; (*b*) species which flourished for a short time under the changing conditions; and (*c*) new forms, chiefly fishes, which persist, or are closely connected with later Devonian forms. It is suggested, from the association of the early Downtonian fishes with marine invertebrates, that the former could live in either salt or brackish water, but gradually became specialised.

Royal Meteorological Society, November 16.—Mr. R. H. Hooker, president, in the chair.—H. **Jeffreys**: The dynamics of wind. Winds can be divided into three main groups according as the pressure differences between places at the same level are mainly occupied in producing acceleration relative to the ground, in guiding the wind under the influence of the earth's rotation or in overcoming friction. They are called Eulerian, geostrophic, and antitriptic respectively. Tropical cyclones and tornadoes are Eulerian, while all winds of side extent are approximately geostrophic; sea and land breezes and mountain and valley winds are mainly antitriptic. Temperature differences will account for the annual pressure variation in Asia, and probably for the permanent winds of Antarctica. In the case of mountain and sea breezes a fundamental part is played by the deviation of the actual average temperature lapse-rate from the adiabatic value.—N. K. **Johnson**: The behaviour of pilot-balloons at great heights. Wind-structure in the upper atmosphere is generally investigated by following a pilot-balloon by means of a theodolite, though at a few stations the balloon is followed by two theodolites situated at the ends of a base-line. Single-theodolite determinations rest fundamentally upon the assumption that the rate of ascent of the balloon is uniform. When a pilot-balloon is observed with two theodolites at the ends of a base-line the actual height of the balloon is calculated from minute to minute, and this method affords a means of testing the accuracy of the single-theodolite method. Experiments on the leakage of pilot-balloons are also detailed. It is concluded that the results of single-theodolite pilot-balloon ascents carried to great heights must be received with great caution.—C. J. P. **Cave**: The cloud phenomenon of November 29, 1920. On November 29, 1920, a cloud with a sharp-cut edge passed across the east of England, and was observed as far north as Worksop, Nottinghamshire, and as far south as Hawkhurst, Kent. The cloud moved from the west; in front the sky was clear, behind completely overcast. The progress of the front has been mapped from sunshine records and observers' notes, and the upper-air conditions have been investigated.

Royal Microscopical Society, November 16.—Mr. D. J. Scourfield, vice-president, in the chair.—G. **Patchin**: The micro-examination of metals, with special reference to silver, gold, and the platinum metals. The presence of foreign bodies, the existence of small quantities of metals, metalloids, etc., which may or may not exert an injurious effect on the material, the constitution of alloys, and the distribution of constituents throughout the metallic mass in relation to the micro-examination of metals, were discussed briefly. The presence of platinum and the platinum metals in gold, silver, and gold-silver alloys and the effect of small quantities of these metals on the surface appearance of cupellation beads were described.—W. C. **Crawley** and H. A. **Baylis**: Mermis parasitic on ants of the genus Lasius. The winged females of ants of the genus Lasius frequently show structural peculiarities, especially stunted wings and atrophy of the ovary, which are the result of infection with a Nematode worm. As Nematodes of this family (Mermithidæ) remain in a larval condition until after emerging from their hosts, complete description of them involves keeping them alive until they attain maturity. This has been done with the form found in *Lasius alienus*, *L. flavus*, and *L. niger*. No mature males of the worm were obtained; since the larvæ were found to have a precociously-developed male gland, the species is possibly a protandrous hermaphrodite. This view is supported by the observation that oviposition begins before or during the shedding of the last larval cuticle.—R. L. **Frink**: The practical value of the microscope in glass manufacture. The use of the microscope as a preventive control in selecting raw materials used as constituents of glass batch and refractories and materials for furnaces and the detection by means of the microscope of the causes of atriæ or cords, stones, seeds, blisters, and other defects in glassware were described. The value of supplementing the polariscope tests of the annealing of glass by microscopical tests was also urged.

Linnean Society, November 17.—Dr. A. Smith Woodward, president, in the chair.—A. Smith **Woodward**: A newly-discovered human skull from the Rhodesia Broken Hill Exploration Company's mine in N.W. Rhodesia. The skull evidently belonged to an extinct race of cave-men, with a skull much resembling that

of the European cave-men of the Neanderthal race, but with an erect skeleton.—A. W. **Hill**: A visit to the Cameroons and Nigeria. The settlement of Victoria and the Botanic Garden there were described. Connected with this garden are the experimental plots of tea and cinchona at Buea, at an altitude of 3300–3600 ft. on the Cameroon Mountain. The Bauchi Plateau, Northern Provinces, was visited, and arrangements were made for collecting specimens of the local flora. More than 600 specimens, comprising a large proportion of new species, have been sent to Kew. The flora of the plateau shows affinities with the flora of Abyssinia and Nyasaland.

PARIS.

Academy of Sciences, November 14.—M. Georges Lemoine in the chair.—P. **Painlevé**: Gravitation in the mechanics of Newton and in the mechanics of Einstein.—M. **Hamy**: A particular case of diffraction of the images of the circular stars and the determination of their diameters.—L. **Fabry**: New formulæ for the calculation of the line of search of a minor planet.—MM. **Gonnessiat** and **Renaux**: An asteroid with an orbit resembling that of a comet. This planet (1920 HZ) was discovered by M. Baade at the Babelsberg Observatory, and he noted its comet-like orbit. Between December 1, 1920, and March 2, 1921, eight positions of this star were obtained with the photographic equatorial of Algiers Observatory, from which the provisional elements have been calculated. The orbit reaches to the distance of Saturn, but the image is clearly that of a planet, and not a comet. Additional observations are desirable before the end of the year, as it will not return for thirteen years.—B. **Déirmendjian**: A new demonstration of a theorem of M. Picard, and some generalisations of this theorem.—J. **Kampé de Fériet**: The general integral of the systems of partial differential equations of hypergeometric functions of higher order.—A. **Lévy**: Recurrent series and the homogeneous forms depending on them.—R. **Gosse**: Two new types of partial differential equations of the second order and of the first class.—J. **Chazy**: The arbitrary functions appearing in the ds^2 of the Einstein gravitation.—R. **Guillery**: Testing machines giving the elastic limit and the modulus of elasticity of metals.—K. **Ogura**: The theory of gravitation in space of two dimensions.—J. **Chappuis** and **Hubert-Desprez**: Researches on stray currents. The stray currents in the soil (of Paris) are produced by insulation defects of the tramway networks (550 volts, continuous current), and cause considerable damage to water and gas mains. Two methods have been worked out for identifying the leaky circuit, one based on the telephone, the other on the lamp with three electrodes. The latter proved to be the better method.—L. **Bouchet**: The variation with time of the pressures created in insulating fluids by a constant electrostatic field. The change with time may be interpreted in several ways, the most probable being the assumption that there is a change in the conductivity of the liquid. The effects observed with alternating currents were applied to calculate the specific inductive capacities of the six hydrocarbons used in the experiments.—P. **Lemay** and L. **Jaloustre**: The oxidising properties of certain radio-active elements. The experiments were made with the bromides of mesothorium, radiothorium, thorium-X, and radium. If solutions of these salts, enclosed in bulbs, are placed in the oxidisable solutions, there is no action, but when intimately mixed, oxidation phenomena were observed with hydroquinone, tincture of guaiacum, ferrous salts, and acid solutions of iodides.—P. **Glangeaud**: The Plomb du Cantal, a large independent volcano, covering nearly a third of the Cantal massif. This region has hitherto been considered as representing a sector of the great Cantalian volcano with a single crater. The author's observations lead to the conclusion that the Plomb du Cantal is an independent volcano, the principal eruptive centre of which was asymmetric with respect to its lava streams.—P. **Loisel**: The radio-activity of the springs of the region of Bagnoles-de-l'Orne. The eight springs examined all proved to be radio-active, but in different degrees. In four of them, all coming from granite, the radio-activity was permanent. The variations are discussed from the point of view of a double origin of the water from the spring.—Ed. **Le Danois**: The variations of the Atlantic waters off the French coasts.—J. **Eriksson**: New biological studies on the rust of mallow, *Puccinia Malvacearum*.—J. **Ripert**: The biology of the belladonna alkaloids.—P. **Freundler**, and Mlles. Y. **Menager** and Y. **Laurent**: Iodine in the Laminaria. There is a loss of iodine, which may amount to 50 per cent. of the amount originally present, when the algæ are dried. The percentage of iodine is almost independent of the place of growth, but varies with the time of year.—A. **Němec** and F. **Duchoň**: The possibility of determining the value of seeds by the biochemical method. An attempt to find a relation between the different enzymes present in the seed and the power of germination. The hydrolysing diastases can persist after the seed has lost its germinating power. But catalase behaves differently, and the activity of the catalase may serve to evaluate in a few minutes the agricultural value of the seeds.—G. **Hinard** and R. **Fillon**: The chemical composition of the starfish. Dried starfish contain about 50 per cent. of calcium carbonate, 35 per cent. of albumenoids, and 7 per cent. of fat, and serve well for manure. The fat has been extracted, and some of its chemical and physical constants are given.—R. **Bayeux**: The subcutaneous absorption of oxygen in mountain climbing or ascent by aeroplane.—A. **Tournay**: The influence of the sympathetic nerve on the sensibility: the effects of the resection of the sympathetic on the residual sensibility of a member the nerves of which have been almost completely severed.—A. **Labbé**: Heterogeneous impregnation.—P. **de Beauchamp**: Biogeographical researches on the tidal zone at the island of Yeu.—R. **Poisson**: Brachypterism and apterism in the genus Gerris.—M. **Aynaud**: Contagious pustulous stomatitis in sheep and goats.—G. B. **de Toni**: Material for the reconstruction of the manuscript A of Leonardo da Vinci in the library of the Institute.

BRUSSELS.

Royal Academy of Belgium, November 5.—M. G. Cesàro in the chair.—C. **Servais**: The geometry of the tetrahedron.—L. **Godeaux**: A rational involution with three points of coincidence belonging to an algebraic surface of the third species.

Books Received.

Wages and the Cost of Living. By Dr. C. V. Drysdale. Pp. 51. (London: Malthusian League.) 6*d*.

The Malthusian Doctrine and its Modern Aspects. By Dr. C. V. Drysdale. Pp. 68. (London: Malthusian League.)

Problems made Easy for Preparatory Schools and the Lower Forms in Public Schools. By R. Tootell. Pp. 75. (Winchester: Warren and Son, Ltd.) 3*s*. net.

Alternating Currents. By G. C. Lamb. Part 1. Pp. viii+73. Part 2. Pp. viii+127. (Cambridge:

At the University Press.) Part 1, 5s. 6d. net; part 2, 7s. 6d. net.

Market Nursery Work: A Series of Six Books on the Cultivation of Crops for Market. By F. J. Fletcher. Vol. 1: Glasshouses and the Propagation of Plants. Pp. viii+75. Vol. 2: Special Glasshouse Crops. Pp. vi+72. (London: Benn Bros., Ltd.) 4s. 6d. each.

Penrose's Annual. Vol. 24 of the Process Year Book and Review of the Graphic Arts, 1922. Edited by W. Gamble. Pp. xii+91+plates. (London: Percy Lund, Humphries and Co., Ltd.) 8s. net.

Ocean Research and the Great Fisheries. By G. C. L. Howell. Pp. 220+20 plates+3 maps. (Oxford: Clarendon Press.) 18s. net.

Letters to My Grandson on the World About Him. By the Hon. Stephen Coleridge. Pp. 124. (London: Mills and Boon, Ltd.) 4s. net.

The Handicraft Art of Weaving. By T. Woodhouse. (Oxford Technical Manuals.) Pp. xii+165. (London: Henry Frowde and Hodder and Stoughton.) 6s. net.

A Text-book of Inorganic Chemistry. By Prof. A. F. Holleman. Sixth English edition, revised. (Issued in English in co-operation with H. C. Cooper.) Pp. viii+528. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 19s. net.

Elementary Chemical Microscopy. By Prof. E. M. Chamot. Second edition, partly re-written and enlarged. Pp. xvi+479. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 25s. net.

The Emission of Electricity from Hot Bodies. By Prof. O. W. Richardson. (Monographs on Physics.) Second edition. Pp. viii+320. (London: Longmans, Green and Co.) 16s. net.

Ministry of Munitions and Department of Scientific and Industrial Research. Technical Records of Explosives Supply, 1915–1918. No. 4: The Theory and Practice of Acid Mixing. Pp. vi+93. (London: H.M. Stationery Office.) 12s. net.

The Psychology of Medicine. By Dr. T. W. Mitchell. Pp. viii+187. (London: Methuen and Co., Ltd.) 6s. net.

Annual Report of the Meteorological Committee to the Air Council for the Year ended 31st March, 1921. Pp. 72. (London: H.M. Stationery Office.) 2s. net.

The Historical Geography of the Wealden Iron Industry. By M. C. Delany. (Historico-Geographical Monographs.) Pp. 62+3 maps. (London: Benn Bros., Ltd.) 4s. 6d. net.

La Matière et l'Energie: Selon la Théorie de la Relativité et la Théorie des Quanta. By Prof. L. Rougier. Nouvelle edition. Pp. xii+112. (Paris: Gauthier-Villars et Cie.) 9.50 francs.

The Manufacture and Uses of Explosives, with Notes on their Characteristics and Testing. By Dr. R. C. Farmer. (Technical Primer Series.) Pp. xii+116. (London: Sir I. Pitman and Sons, Ltd.) 2s. 6d. net.

Dictionary of Botanical Equivalents. French-English: German-English. By Dr. E. Artschwager and E. M. Smiley. Pp. 137. (Baltimore, Md.: Williams and Wilkins Co.) 2 dollars.

Vorlesungen über Thermodynamik. By Prof. Dr. Max Planck. Sechste auflage. Pp. x+292. (Berlin and Leipzig: W. De Gruyter and Co.) 1.28 shillings.

Meddelelser fra Kommissionen for Havundersøgelser. Serie Fiskeri. Bind 6, Nr. 2, 1921: Danish Investigations of Plaice from the North Sea, July, 1919–July, 1920. By Dr. K. Smith. Pp. 68. (Kobenhavn: C. A. Reitzel.)

Diary of Societies.

THURSDAY, DECEMBER 1.

LINNEAN SOCIETY OF LONDON, at 5.—Prof. W. N. Jones: Note on the Occurrence of Brachiomonas.—J. Burtt-Davy: The Distribution of Salix in South Africa.—Miller Christy: The Problem of the Pollination of the British Primulas.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Major C. H. Scott: The Present State of Airship Development.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—L. J. Steele and H. Martin: The Cyc-arc Process of Automatic Electric Welding.

ROYAL MICROSCOPICAL SOCIETY (Metallurgical Section), at 7.30.—The Practical Application of Vertical Illuminators in the Determination of the Structure of Metals and Alloys and in Metallographical Research Generally. Exhibition of Various Types of Vertical Illuminators by C. W. Hawksley and P. Swift.

CHEMICAL SOCIETY, at 8.—R. Mond and A. Wallis: Some Researches on the Metallic Carbonyls.—R. Mond and A. Wallis: The Action of Nitric Oxide on the Metallic Carbonyls.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—R. H. Paramore: Eclampsia and its Incidence.

CAMERA CLUB (at 17 John Street, W.C.2), at 8.15.—Madame Yevonde: Women in Photography.

FRIDAY, DECEMBER 2.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 4.45.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Geophysical Discussion: Certain Geological Consequences of the Cooling of the Earth. Opened by Dr. H. Jeffreys, continued by Dr. Jeans, Prof. Lindemann, Dr. Evans, and Col. Grove-Hills. Chairman, Sir Jethro Teall.

INSTITUTION OF ELECTRICAL ENGINEERS (Students Section), at 7.—H. S. Petch: Automatic and Semi-automatic Railway Signalling.

JUNIOR INSTITUTION OF ENGINEERS (at Caxton Hall), at 8.—B. L. Ladkin: Notes on Maintenance of Electrical Accumulators.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 8.—M. O. Dell: Ideals and Methods in Picture Making.

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—Informal Meeting.

SATURDAY, DECEMBER 3.

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.1), at 3.—Prof. G. S. Boulger: The Sundews: Their Kindred and Neighbours.

MONDAY, DECEMBER 5.

ROYAL BOTANIC SOCIETY OF LONDON, at 3.—Prof. A. W. Bickerton: Gardening (1).

VICTORIA INSTITUTE (at 1 Central Buildings, S.W.1), at 4.30.—Rev. A. C. Robinson: Darius the Median and the Cyropædia of Xenophon in the Light of the Cuneiform Inscriptions.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—W. M. Beckett: Northwich Sewerage and Sewage Disposal Works.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—C. L. Lipman and others: Discussion on Some Recent Developments in the Design of A.C. Instruments.

ARISTOTELIAN SOCIETY (at 21 Gower Street, W.C.1), at 8.—Prof. J. Johnstone: The Limitations of Knowledge.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Business Meeting.

ROYAL SOCIETY OF ARTS, at 8.—A. M. Hind: Processes of Engraving and Etching (Cantor Lecture) (2).

SOCIETY OF CHEMICAL INDUSTRY (at Chemical Society), at 8.—W. L. Baillie: An Autoclave Test for the Grading of Chemical Glassware.—Dr. E. Fyleman: Separation of Adherent Oil or Bitumen from Rock.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—G. M. Gathorne-Hardy: A Recent Journey in Northern Labrador.

ROYAL SOCIETY OF MEDICINE (Tropical Diseases and Parasitology Section), at 8.30.—Dr. Broughton-Alcock, Prof. W. Yorke, and Dr. P. Manson-Bahr: Discussion: Amœbic Dysentery in Great Britain: its Significance and Treatment.—Dr. M. Khalil: Thermotropism in Ankylostome Larvæ.

TUESDAY, DECEMBER 6.

ROYAL SOCIETY OF ARTS (Dominions and Colonies Section), at 4.30.—F. C. Wade: British Columbia: The Awakening of the Pacific.

ROYAL SOCIETY OF MEDICINE (Surgery: Sub-Section of Orthopædics), at 5.30.—N. Dunn and others: Discussion: Stabilising Operations in the Treatment of Paralytic Deformities of the Foot.

WOMEN'S ENGINEERING SOCIETY (at 26 George Street, W.1), at 6.15.—T. Clarkson: The Use of Home-produced Fuels for Commercial Motor Transport.

INSTITUTE OF MARINE ENGINEERS (at 85 The Minories), at 6.30.—Sir D. Wilson-Barker: Weather at Sea, including Clouds, Waves, etc.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—H. M. Edmonds: A New Mode of Producing Sculptures by the Aid of Photography.

RÖNTGEN SOCIETY (at Institution of Electrical Engineers), at 8.15.—M. A. Codd: Some Investigations on Transformer-Rectifier Sets for X-rays.—C. E. S. Phillips: X-ray Tubes Connected in Parallel.

ROYAL SOCIETY OF MEDICINE (Pathology Section) (at Lister Institute), at 8.30.—Dr. V. Korencheusky: Experimental Rickets in Rats, with Demonstration of Specimens.—Dr. G. Ségal: The Association of Typhus Virus with the Various Blood Elements.—A. W. Bacot: Demonstrations of Rectal Infection of Lice by Weigl's Method.—A. W. Bacot and Dr. G. Ségal: The Development of Rickettsia in Lice, following Intrarectal Infection with Typhus Virus.—Dr. R. St. John Brooks and Dr. M. Rhodes: Some Observations on the Hæmorrhagic Septicæmia Group.—Miss E. H. Lepper: Gall-bladder Infections following the Intravenous Inoculation of Coliform Organisms in Rabbits.—Dr. S. P. Bedson:

Demonstration of Histological Material from Experimental Pur pura.—Dr. S. Kanai: Dysentery Immunisation per Os.

WEDNESDAY, DECEMBER 7.

ROYAL BOTANIC SOCIETY OF LONDON, at 3.—Prof. A. W. Bickerton: Gardening (2).

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Sir Kenneth Goadby: Lead-poisoning in Industry.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—S. S. Buckman and J. F. Jackson: Jurassic Chronology. II. Preliminary Studies. A. Certain Jurassic Strata near Eypemount (Dorset). Part I. The Junction Bed of Watton Cliff and Associated Rocks.—J. Stansfield: Banded Precipitates of Vivianite in a Saskatchewan Fireclay.

ROYAL SOCIETY OF MEDICINE (Surgery Section), at 5.30.—Sir Charles Ballance: Ligation of the Innominate Artery.—Sir Lenthal Cheatle: A New Operation for Inguinal Hernia.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—T. L. Eckersley: An Investigation of Transmitting Aerial Resistances.

INSTITUTION OF RAILWAY SIGNAL ENGINEERS (at Midland Grand Hotel), at 6.—Resumed Discussion on Paper by A. E. Tattersall: Three-position Signalling.

INSTITUTION OF SANITARY ENGINEERS (at Caxton Hall), at 7.—S. A. Hill-Willis: Town Planning.

ROYAL MICROSCOPICAL SOCIETY (Biological Section), at 7.30.

ENTOMOLGOICAL SOCIETY OF LONDON, at 8.

ROYAL SOCIETY OF ARTS, at 8.—E. Cammaerts: Literature and International Relations.

SOCIETY OF PUBLIC ANALYSTS (at Chemical Society), at 8.—B. S. Evans: The Estimation of Small Quantities of Antimony in Copper and Brass.—A. Lucas: The Inks of Ancient and Modern Egypt.—C. L. Claremont: Notes on the Analysis and Use of Red Squill in Rat Poisons.

ROYAL SOCIETY OF MEDICINE (Neurology Section) (at Hospital for Paralysis, Maida Vale), at 8.30.—Clinical Meeting.

ROYAL SOCIETY OF MEDICINE, at 9.—Sir Berkeley Moynihan: Medicine in Art.

THURSDAY, DECEMBER 8.

ROYAL SOCIETY, at 4.30.—*Probable Papers.*—Lord Rayleigh: A Study of the Glow of Phosphorus: Periodic Luminosity and Action of Inhibiting Substances (with Experimental Demonstration).—Lord Rayleigh: The Aurora Line in the Spectrum of the Night Sky.—W. D. Womersley: The Energy in Air, Steam, and Carbon Dioxide from 100° C. to 2000° C.—Lt.-Col. J. W. Gifford: Atmospheric Pressure and Refractive Indices, with a Corresponding Table of Indices of Optical Glass.—H. P. Waran: A New Form of Interferometer.—H. Harle: On the Viscosities of the Hydrogen Halides.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Charles Ballance: A Glimpse into the History of the Surgery of the Brain (Thomas Vicary Lecture).

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), at 5.30.—Dr. A. G. S. Mahomed: The Relation of Atmospheric Electrical Variations to the Incidence of Epileptic Fits.—Discussion on the Organisation of the Section.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—L. C. Martin: The Physical Meaning of Spherical Aberration.—Dr. F. Lloyd Hopwood: An Auto-stroboscope and an Incandescent Colour Top.—Lt.-Col. Gifford: Achromatic One Radius Doublet Eyepieces.

CHEMICAL SOCIETY (at Institution of Mechanical Engineers), at 8.—Prof. J. W. Gregory: The Genesis of Ores.

INSTITUTE OF METALS (London Section) (at 85 The Minories), at 8.—S. A. E. Wells: Casting in Metal Moulds.

HARVEIAN SOCIETY (at Medical Society of London), at 8.30.—Sir John Charlton Briscoe, Bart., Sir Sidney Russell Wells, Dr. G. H. Hunt, and Sir William Willcox: Discussion: Is the Anginal Syndrome only of Cardiac Origin?

FRIDAY, DECEMBER 9.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botanical Lecture Theatre, Imperial College of Science and Technology), at 2.30.—Prof. J. H. Priestley and others: Discussion: The Resistance of the Normal and Injured Plant Surface to the Entry of Pathogenic Organisms.

ROYAL ASTRONOMICAL SOCIETY, at 5.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—G. A. Sutherland and L. Clark: The Average Range of -rays in Different Metals.—Prof. E. Wilson: The Sensitivity of Ballistic Galvanometers.—Prof. R. Ll. Jones: The Determination of the Damping Decrement of a Tuning Fork.—Dr. E. A. Owen: The Estimation of the Radium Content of Radio-active Luminous Compounds.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—Continuation of Discussion on Ball and Roller Bearings: Some Recent Types and Criticisms.

ROYAL SOCIETY OF MEDICINE (Electro-therapeutics Section), at 8.30.—Dr. Carelli: Demonstration of his Method of Radioscopic Examination with the Help of Gas Injections.—Dr. Riddell: Demonstration of a Simple Apparatus for Making Serial Radiographs of Pyloric Region in the Horizontal and Upright Positions.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—Clinical Evening.

PUBLIC LECTURES.

(A number in brackets indicates the number of a lecture in a series.)

THURSDAY, DECEMBER 1.

UNIVERSITY COLLEGE, at 5.—Prof. J. E. G. De Montmorency: Feudalism in Western China and in Africa (5).

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—W. Bateson: Recent Advances in Genetics (5).

FRIDAY, DECEMBER 2.

UNIVERSITY COLLEGE, at 4.30.—Dr. J. C. Drummond: Nutrition (8).

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Dr. J. D. Falconer: The Wonders of Geology (Swiney Lectures) (12).

UNIVERSITY COLLEGE, at 8.—Prof. G. Dawes Hicks: Our Knowledge of the Real World (5).

MONDAY, DECEMBER 5.

UNIVERSITY COLLEGE, at 5.30.—Prof. A. Wolf: The Literature of Science.

KING'S COLLEGE, at 5.30.—Dr. W. R. Ormandy: Liquid Fuel Engines (4).

TUESDAY, DECEMBER 6.

KING'S COLLEGE, at 5.30.—Prof. H. Wildon Carr: The Modern Scientific Revolution and its Meaning for Philosophy (9).—Dr. W. Brown: Psychology and Psycho-therapy (8).

WEDNESDAY, DECEMBER 7.

SCHOOL OF ORIENTAL STUDIES, at 12.—Miss Alice Werner: Bantu Tribes of East Africa (5). At 5.—Dr. T. G. Bailey: The Sansis, or Thieves of India: their Language, History, and Customs.

UNIVERSITY COLLEGE, at 5.—Prof. G. Elliot Smith: The Evolution of Man (3).

THURSDAY, DECEMBER 8.

UNIVERSITY COLLEGE, at 5.—Prof. J. E. G. De Montmorency: Feudal Vestiges in America and Elsewhere (6).

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—W. Bateson: Recent Advances in Genetics (6).

KING'S COLLEGE, at 5.30.—H. W. Fitz-Simons: Bridge Construction (5).

BARNES HALL (1 Wimpole Street, W.1), at 8.—Dr. C. Singer: The History of the Doctrine of Infection (Chadwick Lecture).

FRIDAY, DECEMBER 9.

UNIVERSITY COLLEGE, at 8.—Prof. G. Dawes Hicks: Our Knowledge of the Real World (6).

SATURDAY, DECEMBER 10.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 10.30 a.m.—Prof. W. W. Watts: Geology as a Basis for Geography (Lectures for Teachers).

CONTENTS.

	PAGE
A Proposed National Institute of Industrial Microbiology. By A. Chaston Chapman, F.R.S.	425
Currents of Mathematical Thought. By G. B. M.	427
Science and the Community	429
William Osler	430
Our Bookshelf	431
Letters to the Editor:—	
Relativity and Materialism.—Hugh Elliot	432
Metallic Colouring of Beetles.—A. Mallock, F.R.S.	432
The Tendency of Elongated Bodies to Set in the North and South Direction.—E. A. Reeves	433
Table for the Duration of Sunset.—Dr. Willard J. Fisher	433
Relativity: Particles Starting with the Velocity of Light.—Prof. Edward Kasner	434
The Softening of Secondary X-rays.—Dr. J. A. Gray	435
University Relief for Central Europe and Russia.—Right Hon. Sir Maurice de Bunsen, Bart., G.C.M.G.	435
Ophion luteus.—Right Hon. Sir Herbert Maxwell, Bart., F.R.S.	436
The *Zoological Record.*—W. L. Sclater	436
Reflection from Cylindrical Surfaces.—C. O. Bartrum	436
Science in Westminster Abbey. By Eng.-Com. Edgar C. Smith, O.B.E., R.N.	437
The Nitrogen Problem	439
Obituary:—	
Emile Boutroux. By H. W. C.	441
Prof. Peter Thompson	441
Notes	442
Our Astronomical Column:—	
The December Meteors	447
The Origin of Comets	447
Observations of Mars at Flagstaff	447
The Coming of Age of Long-distance Wireless Telegraphy and some of its Scientific Problems	448
Physical Science at the British Association	448
The Ethnology of the Sudan	450
Fuel Research. By J. W. C.	451
University and Educational Intelligence	451
Calendar of Scientific Pioneers	452
Societies and Academies	453
Books Received	454
Diary of Societies	455

THURSDAY, DECEMBER 8, 1921.

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Imperial Water Power.

THE issue of the third and final report of the Water-Power Committee of the Conjoint Board of Scientific Societies is a timely reminder of the importance of a matter which has strangely failed to engage the attention of the community at large, notwithstanding its general perspicacity of judgment in regard to industrial enterprise. It was pointed out in these columns in September, 1918, that the national stores of solid fuel were far from inexhaustible, and that they were being depleted with reckless prodigality, while, simultaneously, another source of energy, viz. water power, ready to hand and only awaiting development, was being allowed to run to waste. Inevitably, sooner or later, the value of this natural supply of energy would be bound to demonstrate itself, but meanwhile no spendthrift could be more indifferent to the squandering of his patrimony than the average citizen to the loss of this form of his country's wealth. Although by no means so well endowed as some other countries, it is estimated that Great Britain has a potentially utilisable amount of water power of more than a million horse-power. Less than a tenth of it is actually developed. This means that some nine hundred thousand horse-power is being dissipated, minute by minute—the equivalent of the consumption of at least four to five million tons of coal per annum.

It is true that the report before us states that, as regards the United Kingdom, "active investigations are being made and definite steps taken by the Committee appointed by the Board of Trade." And we are, of course, aware that hydrographical investigations require time, often a very long time, extending over periods of years which may well run to twenty or even more. Therefore we have no wish to indulge in premature criticism, but we are bound to remark that the only evidence which has so far been adduced of definite projects in view has been the ill-timed announcement of the Severn barrage scheme—a scheme of such tremendous magnitude, founded on data so inadequate, that the public refused point blank to have anything to do with it.

In the present notice we confine our observations to the subject-matter of the report, and its fourteen pages demonstrate in the most pointed way the disparity existing between the steps taken in the United Kingdom and those in other countries for the development of natural sources of water power. Let us extract the following table comparing the summarised figures of the hydraulic powers of the world:—

	Hydraulic horse-power		Percentage of available power at present developed.
	Available.	Developed.	
Europe (Germany, Italy, Switzerland, Spain, Sweden, Austria-Hungary, France, and Norway)	47,300,000	8,450,000	18·0
United States ...	32,000,000	6,500,000	20·3
British Empire ...	60,000,000	3,000,000	5·0

The comparison is unfavourable enough, but the case of the British Empire becomes much worse if we except Canada, where about 72 per cent. of the British total is developed. Reconstituting the table, with the United States and Canada jointly included in North America, we get:—

	Hydraulic horse-power		Percentage of available power at present developed.
	Available.	Developed.	
Europe	47,300,000	8,450,000	18·0
North America ...	50,800,000	8,805,000	17·3
British Empire (except Canada) ...	41,200,000	695,000	1·7

It is scarcely a matter for wonder that the Committee's comment is that "the figures afford striking evidence of the relative scope for development through the Empire." The Committee adds:—

"Taking the Empire as a whole, no attempt is being made to ascertain the total resources, to secure any uniformity in methods of investigation and recording of data, to encourage such investigations as are being made, or to collect the information as it becomes available at a central bureau. At present not even an approximately complete inventory exists, much less the practical

and commercial information that would assist development of this important national resource."

The report contains a summary of the information which, since the issue of the earlier reports, has come to hand respecting India, Ceylon, British East Africa, British Guiana, New South Wales, and Victoria. The information, though serviceable, is of the scantiest character, and merely touches the fringe of the subject.

The Committee then alludes to the proposed Imperial Water-Power Board and makes suggestions as to the principal objects for which such a board would be formed. The following conclusions are arrived at:—

A.—That, in view of the immense water-power resources known to exist in the Empire and of their commercial value, it is of urgent importance that adequate measures should be taken to promote the development of these resources.

B.—That, in many parts of the Empire, it is most desirable that records of river-flow should be instituted and maintained if they are to constitute a safe commercial basis for power development.

C.—That the creation of an Imperial Water-Power Board, with extensive powers to carry out a comprehensive policy for stimulating, co-ordinating, and, where necessary, assisting such development throughout the Empire, is needed.

D.—That a great impetus would be given to the investigation of water resources in the Dominions and Dependencies, by the creation of such a central board to assist and to record such information for the assistance of commercial investors.

E.—That the greater uniformity of methods of investigation and recording to be secured by such a board would much increase the commercial value of the information.

F.—That an Imperial Water-Power Conference be convened in London, if feasible, at an early date. The Committee understands that a proposal has been made to hold such a conference, and that this has been cordially received by the representatives of those of the outlying portions of the Empire which are most directly concerned. Such a conference would offer the opportunity of discussing matters of policy, administration, uniformity of investigation and record, in connection with water-power development, and could not fail to have a useful effect on such development.

The proposal for an Imperial Water-Power Conference to be held at an early date is particularly welcome, and we trust that it will be adequately supported. The time is certainly ripe for a gathering of this kind, and it is to be hoped that it will serve to kindle practical interest in a subject of the most vital importance to the industrial development of the Empire.

We cannot conclude without expressing the great indebtedness of the scientific community to the Committee for its painstaking researches, and especially to its energetic secretary, Prof. A. H. Gibson, who has admirably collated and summarised the material furnished to the Committee and, by his untiring efforts, has rendered possible the presentation of the three successive reports.

The Denomination "Chemist."

BRITISH chemists are placed in the anomalous position, not occupied by their brethren in other civilised countries, of sharing their denomination with practitioners of a different craft—namely, pharmacy. It is, in fact, only by courtesy of the Pharmaceutical Society that they call themselves chemists, because, unless they hold a qualification from that body, they are not legally entitled to do so. The Pharmacy Acts Amendment Bill, read for the first time in the House of Commons on November 3, aims at correcting this error in occupational nomenclature by conferring on the Institute of Chemistry alone the authority to designate any person a "chemist," simultaneously giving to the Society of Pharmacy and Drug Store Proprietors of Great Britain power to place persons on the pharmaceutical register.

It is greatly to be hoped that this, or some similar measure, may find its way on to the Statute Book. The disability it seeks to remove has long been the source of inconvenience and vexation to chemists, but prior to the war it might have been claimed that the matter was a domestic one and did not affect the public welfare. Now, however, it is more than ever important that the public should be assisted in realising the vital necessity of chemistry, in common with other branches of science, for national well-being and progress. Part of the ignorance which prevails in the public mind concerning chemistry may be traced to the nominal association of the subject with pharmacy, an association from which pharmacists themselves do not derive any benefit, and which has led them to adopt a variety of sub-titles, including "cash chemist," "stores chemist," and "Continental chemist." Indeed, it may be argued that pharmacists also have suffered from this confusion, because the daily Press, in despair of explaining the position to the public, commonly refers to chemists as "scientific chemists," thereby implying that pharmacists are not scientific, and thus casting an

undeserved slur on an honourable and useful calling.

It is quite rational that many pharmacists should exhibit reluctance to part with a title which they have legally held since the Act of 1851, and one hallowed by the fact that some of the early chemists—for example, Scheele—were practising pharmacists. In the course of years, however, and following the necessary classification of innumerable chemical observations in a distinct branch of scientific knowledge, the extension of chemistry has passed almost entirely from pharmacists, who are thus designated by a misnomer. It is the purpose of the Pharmacy Acts Amendment Bill to rectify this irregularity as from the first day of January, 1925.

In view of the laudable object of the Bill and the support which the principle at least might be expected to receive from chemists, it is difficult to understand the action of the promoters in holding themselves aloof from the Institute of Chemistry, and not even consulting the council of that body. Consequent on this omission, the official attitude of the Institute has now been set forth in a letter from the registrar to the promoters stating that the council would welcome any legislation tending to remove the present confusion, which it deplores; but it dissociates itself from the suggestion that it should be represented on the central council, which, as proposed in the Bill, would be concerned with the pharmaceutical register. This attitude will be approved alike by pharmacists and by chemists, for the latter have not the slightest claim to participate in the registration of pharmacists; chemists have never suggested, or even contemplated, an action which pharmacists justifiably would resent as an interference with their own functions.

Echinoderm Larvæ and their Bearing on Classification.

Studies of the Development and Larval Forms of Echinoderms. By Dr. Th. Mortensen. Pp. iv + 261 + 33 plates. (Copenhagen: G. E. C. Gad, May, 1921.) *2l. 2s.*

THE development of Echinoderms from the egg presents one of the most striking of life processes known to us. The changes through which the individual passes are even more remarkable than those accompanying the more familiar metamorphosis of a caterpillar into a butterfly. The egg develops directly into a free-swimming larva of bilateral structure, adapted in most cases for pelagic life; within this larva there is gradually formed a body with radial structure and special organs, which, being set free from the larva, grows into the adult sea-urchin, starfish, crinoid, or holothurian—an adult rarely free-floating and generally abiding in one place. It is almost as though there were an alternation of generations, as though the larva bore the young echinoderm as a mother bears a child; and this idea, though not really justified, is forcibly recalled by Dr. Mortensen's account of an ophiurid larva, which, after dropping the young brittle-star, proceeds to reconstitute its own body, and continues life as an independent individual. Dr. Mortensen even suggests, rather audaciously, that it may repeat the metamorphosis.

It is with those larvæ that are adapted to a pelagic life that Dr. Mortensen is mainly concerned. The adaptation consists largely in the development of long rod-like processes, generally known as arms, although they have nothing to do with any structures so called in adult echinoderms. These processes serve as balancers and aid the flotation of the tiny creature. In only a few forms, however, do the skeletal rods support any paddle-shaped expansion of the soft tissues, and in only one, here first made known by Dr. Mortensen, can they be moved like oars by means of special muscles.

The absolute distinction between the larva and the adult, combined with the difference of habitat and the difficulty of raising all the stages in an aquarium, has long hindered the attempt to assign the various larvæ to their respective species. They have, therefore, for practical convenience, been classified and named on an independent system. In the present work Dr. Mortensen's chief aim has been to decide how far this classification agrees with that of the adults, or, to put the matter in another way, how far the differences and resemblances of the larvæ throw light on the affinities of the adult genera and species. Previously the pelagic larvæ of about seventy various echinoderms had been identified, and Dr. Mortensen here describes the development of fifty-five forms previously unknown. The data, therefore, though relatively very few, are enough to warrant a discussion of the problem.

In so many instances do the larvæ of closely related species resemble one another, so often do the larvæ of allied genera agree in important characters, so distinct are the larval forms of the several orders no less than of the classes, that Dr. Mortensen is justified in his conclusion that similarity of larval structure implies the relationship of the respective adults. The converse proposi-

tion, that forms with essentially different larvæ are not nearly related even when there is some resemblance between the adults, may lead to dispute when applied to particular cases. But the conclusion can be tested by other characters. For instance, a Mediterranean sea-urchin, *Sphaerechinus granularis*, approaches Strongylocentrotus in certain features which have led Dr. H. L. Clark to refer it to that genus. Its larva, however, is found to agree with those of the Toxopneustidæ, not with those of Strongylocentrotus. A fairly good test is afforded by the minute structures of the pedicellariæ, and these confirm the conclusion drawn from the larvæ. Although we have as yet only random samples of larvæ from the thousands of living Echinoderm species, still observation, so far as it has gone, does indicate that here is new and valuable evidence of affinity.

In directing attention to this evidence, as when he demonstrated the importance of the microscopic characters of spines and pedicellariæ, Dr. Mortensen has provided the systematist with a new method. It is unfortunate that neither of these tests can (save in some exceptional specimens) be applied to fossils. They cannot oppose the palæontological argument, but they cannot assist it; we can only say that, for genealogical trees based on the evidence of dead ancestors to be correct, the arrangement of their ultimate living twigs must accord with the evidence of their larvæ and of their anatomy generally. In so far as the methods are sound, there can be no conflict between them. The unsound method is that which relies on only one or two characters and in addition too often ignores their historical development. The greater weight should always be attached to the older character. When palæontology cannot tell us directly which this is, we may assume that characters less likely to have been modified by changes in the environment are the older. That principle is, one supposes, consciously or subconsciously the basis of the ill-expressed statement that "anatomical characters" are more important than external characters. The microscopic structure of a minute spine is, whether "anatomical" or not, such a persistent character. Similarly, pelagic larvæ, living in an environment naturally subject to little change, must themselves remain long unchanged, and should therefore yield evidence of affinity more readily than do the later stages in their varied and variable surroundings.

It would be wearisome to repeat here the numerous particular conclusions which Dr. Mortensen bases on the resemblance of the larvæ. The Echinoidea yield the most results: one can recognise a distinct larval type for each of the orders Spatangoidea, Clypeastroidea, and, probably, Diademoidea, and for most of the main families in the regular Echinoids. The classification of the Ophiuroidea is, admittedly, so unsatisfactory that it has not been possible to correlate the accepted families with definite larval types, but for the Asteroidea this has been done to some extent. The larvæ of the Holothurians are not well known, and the Crinoids have not yet furnished a single pelagic larva.

Fortunately the study of the larvæ opens up more general questions, and many will wish to know whether Dr. Mortensen has anything to say on the interrelations of the classes or on the origin of the Echinoderms as a whole. He points out that the Brachiolaria larva of starfishes with its sucking disc, being found only among the more specialised forms, must itself be a late development, so that the sucker cannot be homologous with the stalk of the Crinoids. None the less Dr. Mortensen expresses his "perfect agreement" with the theory which derives all Echinoderms from a simple, bilaterally symmetrical creature—the Dipleurula—now represented by the earliest larval stage in each class, and which explains the five-rayed symmetry and the torsion of the internal organs as due to the fixation of the Dipleurula and its change into a sessile animal with upwardly directed mouth and vent. Seeing that this theory was published in 1900, it may be held to have attained its majority. The later theories of Simroth, A. H. Clark, and J. E. V. Boas are treated by Dr. Mortensen with something as near to contempt as this courteous writer ever permits himself. But as to the origin of the Dipleurula, Dr. Mortensen will express no positive opinion. He sees no connection with the Cœlentera. Certainly the transition was not direct, as Boas suggests; but a possible series of intermediate stages was sketched by the writer of the article "Echinoderma" in the "Encyclopædia Britannica," Editions X. and XI. (1902, 1911), an article always overlooked by writers outside Great Britain.

Other matters of general interest, such as geographical distribution or the influence of temperature, must be left for those who are wise enough to look for themselves at this clearly written, admirably illustrated, and well produced account of a long series of difficult observations. In these hard times we are more than usually indebted to the Carlsberg Fund, which has rendered possible the preparation and the publication of Dr. Mortensen's richly suggestive studies.

F. A. BATHER.

Electrotechnical Theory.

(1) *The Theory of the Induction Coil.* By Prof. E. Taylor-Jones. Pp. xi+217. (London: Sir I. Pitman and Sons, Ltd., 1921.) 12*s.* 6*d.* net.

(2) *The Theory of Direct-current Dynamos and Motors.* By John Case. Pp. xiii+196. (Cambridge: W. Heffer and Sons, Ltd., 1921.) 15*s.* net.

(3) *Engineering Electricity.* By Prof. R. G. Hudson. Pp. viii+190. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) 13*s.* 6*d.* net.

(1) ALTHOUGH it is more than ninety years ago since Faraday made the first induction coil, yet it is only quite recently that a satisfactory working theory of it has been evolved. The problem is one of considerable commercial importance, for induction coils and magnetos are widely used for ignition purposes in gas and petrol engines as well as for X-ray work and radio-communication. Prof. Taylor-Jones has made a special study of the problem, and the theoretical results deduced from his oscillation transformer theory are in good agreement with experiment.

The principal hypothesis he makes is that after the interruption of the primary current the system acts like an oscillation transformer. The currents in both the primary and secondary circuits act like systems with two degrees of freedom. The wave of current in each circuit has two oscillatory components which have in general different frequencies and different damping factors. They sometimes also have different initial amplitudes.

The author's method of treatment is similar to that adopted by Drude. As the value of the current in the secondary at any instant varies along the length of the wire, and as it is practically impossible to discuss distributed mutual inductance, the author supposes that there is a "mutual coefficient" between the primary and the secondary, and a different "mutual coefficient" between the secondary and the primary. He is also forced to suppose that the distributed capacity of the coils can be imitated by localised condensers placed across their terminals. Making these assumptions he has to find the roots of an algebraical equation of the fourth degree in order to solve his differential equations. It is shown that in certain cases the solution can be simplified considerably.

This theory shows how to calculate approximately the size of the primary condenser of an induction coil in order to get the greatest difference of potential between the secondary terminals, while the experiments show that the simplified formulæ obtained by neglecting the resistances of the coils are a help in practical work. Very interesting photographs of the wave form of the secondary potential are shown, and useful discussions of the problems of the Tesla coil and the high-tension magneto are given. We can recommend this book to research workers.

(2) This book will prove very useful to students who are reading for a degree in engineering science. The author develops in a very intelligible way the theory underlying the design, operation, and testing of direct-current machinery. He discusses the dynamo as a machine for converting mechanical into electrical energy, and the motor as a machine for doing the reverse operation. The use of direct-current motors in traction systems is also discussed, and there is a chapter on boosters and multiple-wire systems. A special feature of the book is the large number of engineering problems given, many of which have been taken from recent university examination papers. It would have been an improvement if the answers to all of them had been given.

When discussing the heating and cooling of dynamos the author regards the heat dissipated as being mainly due to radiation. As a matter of fact, the great bulk of the heat dissipated is due to thermal convection. This is the reason why it is customary to make ventilating ducts so as to secure a good circulation of air, the convection increasing as the square root of the velocity of the air current. We notice that the author adopts the induction-factor method of discussing the motor problem—a method first given by Carus Wilson many years ago. It seems particularly helpful when discussing numerical examples. A very neat graphical method of obtaining the losses in a machine by letting it slow down and getting an angular velocity-time curve by means of a tachometer is also given, and the geometrical data found from it give the required constants.

We have found little to criticise in the book. In the statement of Faraday's law given on p. 1 it should be stated that the induced E.M.F. is due to the rate at which the flux of induction (not the number of lines of force) linked with the circuit is altering: the complete formula (11), p. 10, for the self-inductance of a pair of parallel wires is not correct, for the second term should be 1, and not 2. There is a mistake also in the numerical working out of the example at the top of p. 11.

(3) Junior students in technical colleges can be recommended to study Prof. Hudson's text-book. It can also be commended to the notice of engineers who desire to revise their knowledge of the principles on which electrical engineering

is based. The principles are clearly and concisely stated, the author's aim being to develop the reasoning power of the student, and not merely to give him disconnected facts.

The junior student who has no teacher will probably find many difficulties in the book. The two-wattmeter method of measuring power in three-phase circuits is given so concisely that we doubt whether any reader who comes across it for the first time will be able to follow the reasoning. We think also that it is a pity Kelvin's law for the maximum efficiency of power transmission lines is merely stated; a proof could have been given in two or three lines.

The author has adopted the recommendation of the International Electrical Commission, and calls the unit tube of induction the Maxwell. He, however, calls the unit of magnetic flux density —*i.e.* a Maxwell per square centimetre—the Gauss. The recommendation of the I.E.C. is that the unit of magnetic force be called the Gauss. Magnetic force is not mentioned at all, and up to a certain point the author seems to get on very well without it. His definition, however, of permeability as the ratio of the magnetic flux at a point in the medium to the magnetic flux at the same point if an infinitesimal portion of the medium at the point were removed and air substituted is open to criticism.

Teachers find it difficult to give a satisfactory definition of the capacity—or, as the Americans call it, the capacitance—of a condenser. In this book it is defined by means of the charging current for a given sine-shaped wave of potential difference applied to its electrodes, and this gets over many difficulties. Mercury arc rectifiers, which can often advantageously replace rotary—or, as the Americans call them, synchronous—converters receive a chapter to themselves. The book concludes with a large number of photographic reproductions of the latest types of electrical machinery and apparatus. Some of these, however—*e.g.* the electrolytic lightning arrester—are not described in the text. A. R.

British Scientific and Technical Books.

A Catalogue of British Scientific and Technical Books Covering every Branch of Science and Technology, carefully Classified and Indexed. Prepared by a Committee of the British Science Guild. Pp. xviii + 376. (London: British Science Guild, 6 John Street, Adelphi, W.C.2, 1921.) 10*s.* net.

IT would be difficult to discover many readers of NATURE who would not be interested in the present volume, and would not find it a useful addition to their libraries. Hitherto the information within its covers has been obtained only by the wearisome perusal of some 120 publishers' lists, with their varying methods of classification.

The volume is a result of a desire of the British Science Guild to make a complete record of scientific and technical books, other than those intended for primary schools and elementary volumes of like nature, in the current lists of publishers in the United Kingdom. No attempt at selection has been made by the Committee, and the present writer is of the opinion that this course is a wise one. There are many works which are condemned by one authority and yet are recommended by another. The whole difference lies in the point of vision and the purpose for which the work is wanted. This being so, it is far better to place before the inquirer a list of books on a given subject and let him make his choice, knowing as he probably does his own requirement. If skilled advice be needed, with such a list at hand it is probable that any expert would be willing to give advice.

The entries are arranged in subject order in a classification devised to be such that, so far as practicable, related subjects are placed near to one another, the titles under each head or subhead being arranged alphabetically according to authors' names.

If there is any doubt as to the particular group or groups in which a subject would appear, a reference to the alphabetical subject index at the end of the volume at once indicates where it will be found. This alphabetical subject index adds considerably to the value of the work, as it is a guide to the contents, rather than a mere indication of the titles, and it is evident that much care has been taken in its compilation. A very complete alphabetical list of authors, collaborators, and translators is also included.

The insertion of the date of publication of nearly every item is an extremely useful feature. This information very seldom appears in a publisher's catalogue, and one is left in ignorance as to whether a book is twenty years old, or the latest publication on the subject.

Apart from the purpose for which the work has been produced, it constitutes a valuable post-war survey of the British resources in this field of literature. With its aid some lacunæ may be disclosed which, it is hoped, British authors and publishers will be quick to fill.

The trustworthiness of the volume has been very thoroughly tested, and although some hundreds of items have been checked, the reviewer found no serious reason for criticism. A few prices are not correct, but this is only to be

expected considering the fluctuations in price which have occurred during the last few months. The titles of one or two important works do not appear, but inquiry elicits the information that they are out of print, and thus do not come within the scope of the book. What at first appears to be an omission of the valuable Reports on the Progress of Applied Chemistry, published by the Society of Chemical Industry, is evidently due to the decision that the books included should be obtainable through booksellers in the usual way. The reason for the inclusion of a work on "Sea-water Distillation" under the heading of General Chemistry is not quite easily explained, but it is probably due to a mechanical error in sorting. Such slight blemishes do not, however, detract from the value of the book, and considering the amount of tedious work which must have been incurred in its compilation, it is a matter for congratulation that so few occur.

Booksellers and librarians would be well advised to include a copy amongst their works of every-day reference, as they will find that it will save them a great deal of unnecessary labour.

The volume is well printed, and the binding should stand considerable wear and tear. An unusual feature is that the end papers are wholly reinforced with a fine gauze or "mull," in a manner which should tend to strengthen the binding very materially.

The British Science Guild has produced a notable volume, and it is much to be hoped that its sale will justify the expressed desire to issue an annual edition.

F. W. CLIFFORD.

The Statecraft of Ancient Greece.

The Works of Aristotle. Translated into English under the editorship of W. D. Ross. Vol. 10, *Politica,* by B. Jowett; *Oeconomica,* by E. S. Forster; *Atheniensium Respublica,* by Sir Frederic G. Kenyon. (Unpaged.) (Oxford: At the Clarendon Press, 1921.) 15*s.* net.

THE new volume of the Oxford Aristotle will probably appeal to a wider range of readers than any of the others, because it deals with statecraft, theories of government, economics, and constitutions. The "Politics" is no doubt the best known of Aristotle's works outside the body of students who have had to read the treatises for university courses. This is in large part due to the splendid translation made by Jowett in 1885. It is this translation which is reprinted in the present volume, revised and brought up to date by Mr. W. D. Ross, the editor of the series. With it is included Mr. E. S. Forster's translation of "Œconomica," an Aristotelian work which is not by Aristotle, but attributed by the translator to a disciple who lived earlier than the second century B.C. The third work in the volume is the treatise on the constitution of Athens, discovered in a papyrus in 1891. The translation is that originally made by Sir Frederic G. Kenyon, but now revised by him and in part reconstructed from fragments since discovered.

When we read Aristotle we have to keep reminding ourselves that we live in a different world, for he seems to be discussing always our own modern problems. It is difficult to realise that questions so vital to us were commonplace in the ancient world, and we are often tempted to exclaim with the Hebrew preacher, "There is nothing new under the sun." It must be rather a shock to those who have heard of Thales of Miletus as the first of the great line of Ionian natural philosophers to be told that he once enriched himself by cornering the olive presses. Certainly the moral Aristotle draws is designed to show that the philosopher despises wealth, for he has the opportunity of acquiring great riches if he chooses to use his wisdom for a worldly end. The other story of the man of Sicily, presumably a banker, who used the money deposited with him to buy up the iron-ore, and made a profit for himself of more than 200 per cent., has a still more curious moral. The man was expelled from Syracuse as a dangerous person who might get too rich, but he was allowed to take his money with him! Aristotle's moral is that the State would do well to take example from him. Even "the Great Illusion" was exposed in the ancient world, and produced, in one instance at least, more effect than Mr. Norman Angell has produced in our generation. We are told that "Eubulus, when Autophradates was going to besiege Atarneus, told him to consider how long the operation would take, and then reckon up the cost which would be incurred in the time. 'For,' said he, 'I am willing for a smaller sum than that to leave Atarneus at once.' These words of Eubulus made an impression on Autophradates, and he desisted from the siege."

H. W. C.

Our Bookshelf.

The Outline of Science: A Plain Story Simply Told. Edited by Prof. J. Arthur Thomson. Pp. ii+40. (London: G. Newnes, Ltd., n.d.) 1*s.* 2*d.* net.

FROM its title this work (which is to be completed in about twenty parts) claims no more than to give an *outline* of science. Astronomy occupies

some twenty-four pages of part 1; it is necessarily treated very summarily, and much of the information is given by diagrams. This makes it essential that these should be accurate and self-explanatory. Fig. 2 is open to the criticism that it fails to show the great differences between the interplanetary spaces; the orbits are represented as equidistant, and Saturn's period is given as twelve years. Fig. 11 quite fails to show the sun's pre-eminence compared with the planets. The letterpress under the portrait of Prof. J. C. Adams is disfigured by the substitution of Neptune for Uranus as the perturbed planet. Fig. 6 (the total solar eclipse of 1919) is described as being taken at Greenwich, instead of Sobral, Brazil. On p. 23 it is stated that "mutual friction raises at least a large part of them (the meteors forming a comet) to white heat." This is quite improbable, since the meteors are travelling on parallel paths with practically equal velocities. In the large diagram illustrating the spectroscope the luminous body appears to be a star, since the sky is dark and other stars are shown. However, no object except the sun could throw a large, bright spectrum on a screen, and in this case a slit (absent from diagram) would be essential for showing the Fraunhofer lines.

There are several excellent reproductions of solar, lunar, planetary, and nebular photographs, and a bold coloured drawing of a gigantic solar prominence. The descriptive matter is attractively written, and includes a short exposition of the theory of giant and dwarf stars, and of the Moulton-Chamberlin planetesimal theory, which, however, postulated the approach of but one star to our system, not one for each planet, which latter would be utterly improbable.

A. C. D. CROMMELIN.

Die Ursachen der diluvialen Aufschotterung und Erosion. By W. Soergel. Pp. v+74. (Berlin: Gebrüder Borntraeger, 1921.) 18 marks.

IN translating the title of this suggestive work we are troubled by the term "diluvial," which has, we fear, become fixed in German terminology; also by the fact that we have no equivalent for the expressive word "Aufschotterung." The author refers the formation of the true Schotter, the boulder-beds, to epochs of cold semi-arid climate, when frost acted on a surface free from vegetation. Weathering was then mechanical. Valley-erosion, on the other hand, indicates a humid climate, when vegetation protected the rocks from block-denudation, when weathering was chemical, and when the free flow of water worked havoc with the preceding products of "Aufschotterung." Herr Soergel shows how even so large a cause as upheaval or subsidence of the land is unlikely to promote regional erosion or aggradation in a network of valleys running in different directions. The tilting or buckling of the land-surface in such a case leads to changes that vary from one district to another. Hence the author sees in the regional features of "diluvial" times in Europe evidence of repeated climatic change, and he finds support in the animal remains that are associated with deposits formed respectively in epochs of erosion and glacial aggradation. The "monoglacial" view is thus rejected; boulder-beds connected with epochs of erosion are merely local and do not indicate a continuity of the cold conditions that produced the great "Aufschotterungen."

G. A. J. C.

Flora of the Presidency of Madras. By J. S. Gamble. Part 4, *Rubiaceae to Ebenaceae.* Pp. 579–768. (London: Adlard and Son and West Newman, Ltd., 1921.) 10*s.* net.

THE present instalment of this handy little flora is mainly occupied with the two large families Rubiaceæ and Compositæ, the former including representatives of forty-five genera, and the latter of sixty-two. The Rubiaceæ include plants of widely varying habit; small-flowered, creeping, erect, or climbing herbs recall the development of the family in temperate climates, and shrubs or trees represent the tropical development. The latter include handsome flowered species, as in the Ixoras and Gardenias. *Hydrophylax maritima,* a succulent creeping herb, is a useful sand-binding plant on the dunes of the east and west coasts. Many genera familiar in temperate regions occur among the Compositæ in the hill districts; the Dandelion is an introduced weed both in the Nilgiris and the Pulney Hills. The nineteen species of the genus Senecio include, besides herbs of our ragwort type, several shrubby climbers; and Vernonia, with twenty-nine species, includes herbs, shrubs, and small trees.

In contrast with the rich development of the Ericaceæ and Primulaceæ in Northern India the Madras Presidency is very poorly represented. Ericaceæ comprise only one Gaultheria and one Rhododendron, and Primulaceæ six species in all, one of which, *Anagallis arvensis,* the pimpernel, occurs only in the blue-flowered form. The genus Primula is absent; but there are six genera of the allied family, Myrsinaceæ, one of which, Ægiceras, is a constituent of the mangrove forests of the sea-coasts and tidal creeks.

A Handbook of Laboratory Glass-blowing. By B. D. Bolas. Pp. vii+106. (London: George Routledge and Sons, Ltd.; New York: E. P. Dutton and Co., 1921.) 3*s.* 6*d.* net.

ALTHOUGH it is without doubt desirable to have a professional glass-blower attached to a physical or chemical laboratory, a knowledge of simple glass-blowing is essential to students generally. While Mr. Bolas carries the subject rather further than the simple repair of apparatus, for he describes also the construction of glass laboratory ware, he gives clear and concise instructions for the manipulation of glass which should prove of considerable service to laboratory workers. Most of the operations are illustrated by clear line drawings of the various stages through which the material passes before it assumes its final form.

Stanford's New Map of the Pacific Ocean. Size 30 × 22½ in. (London: E. Stanford, Ltd., n.d.) Coloured sheet, 4*s.*; mounted to fold in case, 6*s.* 6*d.*

A MAP of the Pacific Ocean showing the distribution of political interests should prove useful at a time when international problems centre largely on that ocean. Messrs. Stanford have produced an excellent map which has the merit of being on Mollweide's equal area projection, and showing the main features of relief by layer colouring. Spheres of interest are shown by distinctive bands of colour and the principal submarine cables and wireless stations are clearly marked. A few corrections might be made in a later edition. The Banks and Torres Islands are within the joint Anglo-French administration of the New Hebrides and not under the High Commissioner of the Western Pacific. The Chesterfield Islets, although of very slight importance, form part of the French colony of New Caledonia. The Portuguese foothold in Eastern Timor should be marked. The small group of the Tasman Islands, north of the Solomons, used to be German territory and should presumably now be included within the area of the Australian mandate. But these are all minor points which do not affect the general usefulness of this well-printed map. It is accompanied by a sixteen-page pamphlet of statistical matter.

Elementary Principles of Continuous-Current Armature Winding. By F. M. Denton. (Pitman's Technical Primers.) Pp. x+102. (London: Sir Isaac Pitman and Sons, Ltd., 1921.) 2*s.* 6*d.* net.

THE greater part of this compact little treatise has appeared in the columns of a contemporary. The principles governing the arrangement and proportioning of armature windings are worked out by a simple progressive treatment with very little mathematics, and some useful rules and comparative data are given.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Propagation of Waves in an Isotropic Solid.

THE velocity of waves in an isotropic solid is proportional to the square root of the coefficient of that kind of elasticity called into action by the displacements which constitute the wave-motion. These displacements may involve either the simple rigidity (n), the volume elasticity (κ), or more generally a combination of both. The effective elasticity will depend partly on the nature of the initial disturbance, and partly on the boundary conditions

If torsional vibrations are propagated along a rod, the wave-velocity varies as $\sqrt{n}$; or if the pressure over the whole surface of a solid sphere varies simultaneously, a wave travels inwards with a velocity proportional to $\sqrt{\kappa}$. If the wave-length is great compared to the radius of the sphere, the latter is merely compressed and dilated as a whole; on the other hand, when wave-length/radius is small, the amplitude of the vibration increases as the wave travels inwards on account of the same energy being embodied in a shell of smaller mass.

At the centre of the sphere, if the limits of elasticity did not operate, the amplitude would be infinite, but in any real case disruption of some sort would occur.

Analogies may be found in other cases where a constant energy content is confined in a continually decreasing mass, as, for instance, in the "cracking" of a whip, or in the drop thrown up in the centre of a circular basin of fluid after a small wave has been initiated round the circumference.

When longitudinal waves are propagated along a rod of which the transverse dimension (A) is small compared to the wave-length (λ), the velocity is proportional to $\sqrt{\text{Young's modulus (E)}}$, which contains both n and κ.

Such longitudinal waves always occasion lateral motions of the particles proportional to Poisson's ratio (μ) for the substance, but these are of little importance as long as λ/A is great. If, however, A/λ is great, the lateral motion at the surface of the rod might, if the elasticity were still represented by Young's modulus, become greater than the longitudinal amplitude of the original wave; in fact, the two amplitudes would be equal when $A/\lambda=\mu$.

In reality, however, the surface deformation which must accompany the longitudinal wave exerts a normal force on the interior parts, and thus reduces the lateral motion to a quantity which decreases exponentially from the surface inwards.

The conditions for the elasticity defined by Young's modulus are that the deformations shall produce no normal force at the free surface, while for the elasticity which governs the same class of displacements in the far interior the conditions are that there shall be no normal motion.

If a force P parallel to Z acts on a unit cube and causes a contraction, α, then if no forces act parallel to x and y there is a lateral extension $\mu\alpha$ in both directions. If now keeping the stress P constant, a force $E\mu\alpha$ is caused to act parallel to x and y, the lateral dimensions are restored to their constrained magnitude, and the longitudinal strain is decreased by $2\mu^2\alpha$. Thus if the coefficient of the interior elasticity is denoted by B, $B(1-2\mu^2)=E$, or $B=E/1-2\mu^2$.

The expression for E in terms of n and κ is $9n\kappa/3\kappa+n$ and for μ, $3\kappa-2n/2(3\kappa+n)$. In Fig. 1 curves are given showing the values of E and B as multiples of n in terms of μ. At the surface of a solid the wave-velocity is always proportional to $\sqrt{E}$, but gradually increases to $\sqrt{B}$ in the interior. Assuming that the lateral displacements vary as $e^{-\frac{y}{c}}$ (y normal to the free surface), it will be found that when λ/A is great $c=\frac{\lambda}{2\pi}\frac{E}{n}$.

Thus at the depth of one wave-length the coefficient of elasticity nearly approaches B. If a plane wave surface starts from OY (Fig. 2) in the direction of Z, its surface will, as it progresses, assume the form sketched at Z_1Y_1. Earthquake waves must be affected by the change from B in the interior to E at the surface, and if a plane wave of compression were vertical at its source it would afterwards cut the surface at a more or less acute angle.

In iron or glass $\sqrt{B}>\sqrt{E}$ by something like 10 per cent., and it would be interesting to examine the velocity of very short waves in rods of such materials.

The chief experimental difficulty would be to originate waves the length of which was only a small fraction of the diameters of the rods.

Since compression at the surface of a solid depends on E, it would be just possible for a precipice to exist where the height and density of the material made the pressure at the base equal to the "crushing" limit. Taking this limit from some of the text-

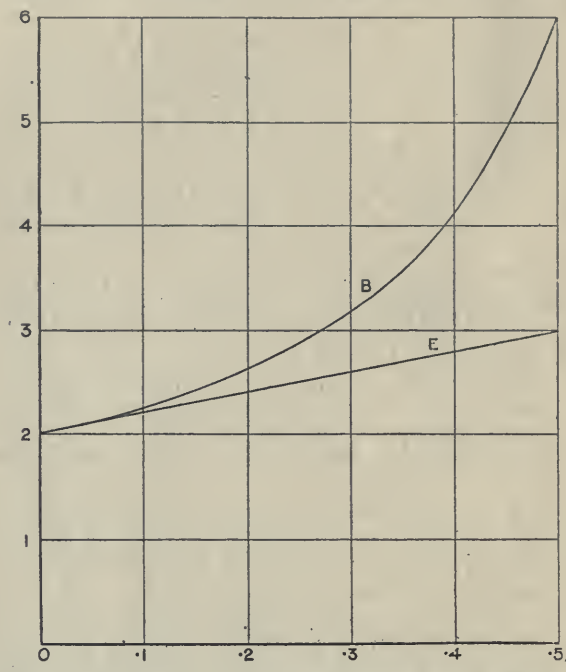

FIG. 1.—The ordinates of the curves show respectively the values of the coefficients E and B as multiples of the rigidity (n) in terms of Poisson's ratio (μ).

books on the "strengths of materials," it appears that the highest vertical face which could stand is, for granite, marble, or gneiss, 8000–14,000 ft.; various limestones, 5000–9000 ft.; various sandstones, 2500–9000 ft.; and various chalks, 500–2500 ft.

I believe that no real precipice (*i.e.* vertical wall of rock) is known which exceeds, even if it reaches, a height of 6000 ft., nor is it to be expected that

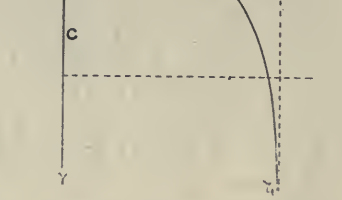

FIG. 2.—OZ is the surface of the ground: OY indicates a vertical plane wave surface; Z_1Y_1 indicates the same surface after advancing in the direction OZ.

weathering and other influences would allow of anything like the maximum crushing stress to be borne permanently at a free face.

If a solid were compressed by a piston in a perfectly inextensible cylinder, the strain produced would not be simple volume compression, but volume compression combined with a certain amount of shear, and if the shearing strain exceeds the shear limit, some molecular rearrangement must take place, although the boundary conditions prevent any actual rupture. The very large differences in the densities of various chalks and limestones may, perhaps, be indications of the pressures to which they have been subjected after their deposition. A. MALLOCK.

9 Baring Crescent, Exeter, November 11.

The Action of Sunlight: A Case for Inquiry.

RECENTLY the *Times* published an article by Prof. Benjamin Moore on the action of sunlight, and the ensuing correspondence revealed an extreme contrariety of opinion upon a subject of primary and profound biological and civic importance. Upon such a question men of science should surely have reached some agreement, but it is not so.

Even amongst those who are certain of the superlative powers of sunlight against certain forms of disease, which I have called the diseases of darkness, there is extreme contradiction of opinion as to its *modus operandi*, and this is not merely an academic question, but vitally concerns our urban lives. For about thirty years it has been believed that the healing power of sunlight resides in its ultra-violet rays, which are not light at all in the visible sense. If that be true, it is so much the worse for us in London or Glasgow or Liverpool or Belfast, who are near sea-level, where the solar radiation is very poor indeed in those rays.

I have lately seen the work of Dr. Rollier at Leysin, in the Alps, where ultra-violet rays abound. Since then I have seen for myself the work, second only to his, of the Treloar Hospital, under Sir Henry Gauvain, at Hayling Island, on the English Channel. The view of Prof. Benjamin Moore and Dr. Leonard Hill that the ultra-violet rays are not useful, but dangerous, needing exclusion by the development of pigment in the skin, is thus supported. In a recent letter to a contemporary, *à propos* an article of mine on this subject, Prof. W. M. Bayliss has further questioned the value of the ultra-violet rays, and has pointed to the need for an inquiry.

It is clearly all-important for us to know whether our ordinary English sun, "the light of common day," provides us, at our customary humble levels of business, with enough of the very kinds of radiation which avail for life and against death. I believe that it does, and my belief is strongly confirmed by the reading of the recent papers by Dr. Carl Sonne, of the Finsen Light Institute, at Copenhagen, according to which the healing power of sunlight is due to its familiar, visible rays.

We expect at any moment the final report of Lord Newton's Committee on Smoke Abatement. It will, I am confident, be a cogent and valuable document. Already the time has come, predicted by Dr. Hill a few weeks ago, when we should be longing for the sunlight—and the wise and well-to-do are following the advice of railway advertisements to "Escape Winter Fogs" by going to Monte Carlo. They are, however, "statistically contemptible." The mass of the population, upon whom our Empire chiefly depends in peace and war, have to winter "very otherwise"—here, at least, but not, say, in Winnipeg or Calgary, as I learnt there recently.

Following the publication of Lord Newton's report, let us have a co-ordinated inquiry into the action of sunlight in health and disease, under the fortunate auspices, to which already we owe so much, of the Medical Research Council and Sir Walter Fletcher,

its secretary. For so wide a theme we shall need the physicist and chemist and biochemist and physiologist and tuberculosis expert and sanitarian, at least.

In the upshot it will appear, I believe, that "the things men live by" (and for lack of which they die), even in our complex and marvellous cities, are very simple. The primary laws remain. As Bacon said, "Nature can be commanded only by obeying her." For the body we need little more than light and air and water and fresh food—*pâté de foie gras* and *eau de Cologne* and champagne are superfluities; and for the soul, as Dr. Cabot, of Boston, says, we need no more (nor less) than work and play and love and worship.

C. W. SALEEBY.

Royal Institution, November 26.

Relativity and Materialism.

My reply to my friend Mr. Hugh Elliot is quite plainly that, so far as I can discover from his letter in NATURE of December 1, and from his book, and from an article I have read of his, and from an essay which I believe nearly won the five-thousand-dollar prize, he has not understood the principle of relativity. He discusses with very great ability and lucidity the negative results of the experiments and all the illustrations of conflicting experience in relatively moving systems of reference, and, for aught I know, he may be quite familiar with the differential equations which the relativist mathematicians use, but all that he does is to offer a plausible explanation of the phenomena on his materialistic hypothesis. That is not the principle of relativity, yet, strangely enough, he seems quite convinced that it is. The principle of relativity is essentially the construction of the universe from pure concrete experience without any causal theory of experience whatever. This is the very antithesis of materialism. To affirm the contrary is like saying that Berkeley is a materialist. It is simply evidence that words are being used without knowing their meaning.

But let me bring the matter to the test. The universe, according to Minkowski, Einstein, and the other relativists, is a four-dimensional continuum. In this universe there is no simultaneity. This does not mean that we have to calculate the simultaneity of events on a new principle; it means that simultaneity in the accepted meaning has lost all significance, and, in fact, represents nothing; no two events are simultaneous in any absolute or universal meaning. Also in this universe there is no universal system of geometry, nothing which even takes the place of the Euclidean geometry of the Newtonian absolute space. Every point-event has its own geometrical system. The whole rationality of these concepts lies in the conception of a scientific reality constituted wholly of concrete experience. Hence every point-instant in this universe the track of which forms a world-line is taken primarily from its own point of view, according to which it is central and its direction straight.

How can anyone accept this basis of scientific reality and be a materialist? Materialism is a metaphysical theory which may be right, and relativity is an anti-metaphysical theory which may be wrong, but acceptance of the one is the rejection of the other.

H. WILDON CARR.

King's College, London, December 2.

PROF. TYNDALL, in his "Scientific Use of the Imagination," allowed a fair play-room to this faculty in scientific research. Dr. Norman Campbell would seemingly restrict its use to a sphere in which phenomena could be submitted to the check of experiment. In his letter in NATURE of November 24, and in his contribution to the Einstein controversy in the issue of February 17 of the present year, he demurs to the use of arguments based on anything that cannot possibly happen.

Dr. Campbell would thus rule out, as scientifically invalid, Prof. Eddington's conception of a perceptive being, travelling at the velocity of light, as having no knowledge of time, and as living in a perpetual present. Such a being and such a condition of things could not be subjected to experiment, and therefore a conclusion drawn from them would be futile.

Einstein's argument based on an imaginary "lift" hanging in space far removed from matter, in which an observer draws deductions, from his experience, as to his gravitational field, would also come under Dr. Campbell's censure, as being outside the region of experiment.

Dr. Campbell seems to me—but I may be quite wrong—to lay down a new canon of scientific method.

EDMUND MCCLURE.

80 Eccleston Square, S.W.1, November 28.

The Radiant Spectrum.

PROF. RAMAN has recently directed attention (NATURE, September 1, p. 12) to some observations by Brewster on what the latter called the "radiant spectrum" (*Phil. Mag.*, vol. 2, p. 202, 1867). Brewster advanced the hypothesis that the phenomenon was due to the granular surfaces of the eye rendering the ultra-violet rays visible by fluorescence. Prof. Raman proposes the alternative hypothesis that diffraction by the corneal corpuscles of the eye accounts for the phenomenon. Brewster's view is at variance with the fact that when a colour screen, opaque to ultra-violet rays, is placed in the optical path between the source, the prism, and the eye, it does not render the "radiant spectrum" appreciably less visible. Fluorescence set up by ultra-violet rays can therefore be safely excluded as a possible cause of the phenomenon. Prof. Raman's view that diffraction effects by the corneal corpuscles of the eye are responsible is at variance with the following facts:—

(1) That if the head of the observer be rotated, so as to rotate the eye about its optical axis, and therefore cause the corneal corpuscles to take up new meridians, then little or no change, such as might be expected, is seen to occur in the radiant spectrum.

(2) That by placing a suitable screen between the prism and the eye, it is possible to exclude the ordinary direct spectrum of the light source and yet still to observe the so-called "radiant spectrum." If the effect was produced by the eye, such a cutting off of the direct spectrum should also have the effect of destroying any diffraction effects produced, since all light would thus be prevented from reaching the eye.

(3) The "radiant spectrum" can be seen on the ground glass of a photographic camera, and can presumably, therefore, be photographed. Since no corneal corpuscles are present in a glass lens the "radiant spectrum" should not, on Raman's hypothesis, be visible in this case.

The following hypothesis fits in with all the above facts, viz. that the "radiant spectrum" originates by diffraction principally at the prism surfaces themselves. Four observations are in favour of this view:—

(1) That a prism with very perfectly polished sides gives a very weak radiant spectrum.

(2) That if the surfaces of such a prism be covered with finger marks, the radiant spectrum becomes very much more intense.

(3) That a prism with very scratched or poorly polished surfaces gives an intense radiant spectrum.

(4) But if now the surfaces be oiled to obliterate the scratches the radiant spectrum is much diminished in visibility.

If the surfaces of the prism itself are responsible, as the above evidence would seem to show, the question arises: Why should the radiant spectrum always appear to have its achromatic centre at apparently a fixed position in the ultra-violet part of the ordinary spectrum of the source?

The following explanation may be advanced: When light passes through an optical surface which is marred by random imperfections, a portion of the light is lost in the formation of a vast number of impure spectra of various dispersions, orders, and meridians, which are oriented about the centre formed by the image of the source.

In all these spectra the short wave-length rays are less deviated, and therefore appear closer to the source, than do the rays of longer wave-length, which shows that the spectra are produced by diffraction and not by refraction.

It will be observed further that the spectra are arranged according to their length, short spectra being nearest to the source, long spectra farthest from it.

If now this congeries of scratch spectra be looked

FIG. 1.—"Radiant spectrum" before refraction.

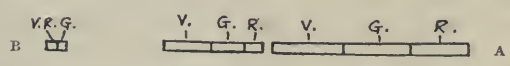

FIG. 2.—"Radiant spectrum." after refraction.
R, red; G, green; V, violet; S, source.

at by an observer through a prism, the position of the colours in the scratch spectra will be altered: on one side of the source the scratch spectra will be still further dispersed since the dispersion of rays of different length already produced by diffraction is added to by the dispersion of the prism, as shown at A in Figs. 1 and 2, while on the other side they will be less dispersed, as shown at B, because the dispersion produced by the prism is in the opposite direction to that produced by diffraction. But since the scratch spectra vary in length according to their angular distance from the source, there will be in a certain position a scratch spectrum the dispersion of which is equal in length but the opposite way round to that of the prism through which the scratch spectra are being observed; the rays in this spectrum will thus be recombined to form white light, and this will form the achromatic centre of the apparent "radiant spectrum." The other scratch spectra will from similar reasoning rearrange themselves in order about the achromatic centre according to their length.

It should follow from this that the achromatic centre should always be beyond the violet end of the spectrum of the source by a distance roughly equal to the length of the spectrum of the source itself. That is, that the displacement of the achromatic centre should vary with the dispersion of the prism and not with its deviation. Experiment shows that this is the case. This explanation obviously covers the case where the optical surface setting up "scratch" spectra is that face of the prism which is situated farther from the observer. With regard to the near face, it will be seen that the final image presented to the eye is the same, whether diffraction effects produced by the imperfections of an optical surface are afterwards refracted by a prism, or whether the prism first produces the refraction spectrum, which is, in its turn, diffracted, so long as parallel rays are used to illuminate the two systems. But a small bright source situated some distance from the eye produces approximately parallel light, and therefore, if the path difference of optical surface and prism is small, the same effect will be produced whichever is placed nearer the eye.

The hypothesis that the "radiant spectrum" is produced by diffraction due to imperfections in the prism surfaces, therefore, fits in with all the observations that I have been able to make. But it does not exclude the possibility that the optical surfaces of the eye add their effects to those produced by the prism surfaces. Experiment shows, however, that they are very slight, which points to the surfaces of the cornea and crystalline lens being very free from irregularities.

It remains to consider Brewster's final observations on the "radiant spectrum." He found that the centre of the figure was closer to the direct spectrum by red light, and farther from it with blue light than it was with green or yellow light. These facts can be readily explained if the differences in the relative dispersion of the rays in the cases of prismatic and diffraction spectra be considered. Since the red rays in the prismatic spectrum suffer small relative dispersions, short scratch spectra close to the image of the source will be overfolded, and the centre of the figure will therefore be close to the direct spectrum. Since blue and violet rays in the prismatic spectrum suffer large relative dispersions long scratch spectra far from the image of the source will be overfolded, and the centre of the figure will therefore be some distance from the direct spectrum. By green and yellow rays, which suffer medium relative dispersion, the centre of the figure should be a medium distance from the direct spectrum, as Brewster found was the case.

H. HARTRIDGE.

King's College, Cambridge.

Microscope Illumination and Fatigue.

I WAS much interested in the letter from Mr. H. J. Denham on the above subject in NATURE of November 17. It is gratifying to know that the importance of adjustment of the intensity of illumination in the microscope is recognised. At the National Institute for Medical Research several workers are provided with appliances for modifying this intensity, and they are agreed that it increases their comfort and efficiency. But I am in disagreement with the method that Mr. Denham adopts. The subject is too lengthy to discuss in full, but it is, I think, an accepted principle that the dominant wave-length in any light used for the microscope should be as short as possible, and that any light-modifier should reduce intensity without any alteration of quality. It is also well known that the wave-length of the dominant radiation is inversely proportional to the absolute temperature of the radiating substance, which in the case of the "Pointolite" lamp is tungsten. To alter the intensity of such an illuminant, therefore, by means of a resistance results in such an alteration of quality that the light

becomes useless for exact work, and we long ago tried and discarded such a method for this reason.

A method that does not possess this disadvantage is to use partially platinised glass screens. These can easily be made by methods already known, and the effect on any illuminant is to reduce its intensity without changing its character. In my own practice I have a number of these, the absorption of which has been tested by a photometer, mounted in a small frame so that they can in a moment be passed along in the path of the beam. The process is, in fact, less troublesome than operating a sliding resistance. The light can therefore be reduced by a known amount at each step. The advantage of this when a change is made, say from a low power ocular to a high one, is obvious. The relative light-transmitting power of the oculars is known, and it is, therefore, only necessary to move a suitable screen into position in each case when the intensity of illumination in the field of view is the same for both. Should a gradual change of intensity be required, then an arrangement recently placed on the market by Messrs. R. and J. Beck, Ltd., will do all that is necessary. It consists of two graduated neutral wedges which are moved across one another by a simple gearing so that any degree of opacity may be obtained and the light controlled between wide limits. J. E. BARNARD.

National Institute for Medical Research,
Hampstead, London, N.W.3, November 29.

Hybridity and the Evolution of Species.

DR. J. P. LOTSY, in his letter to NATURE of November 24, asks zoologists to answer the question: Is there any evidence that the presence of oligopyrene and apyrene sperms in some insects and molluscs is due to hybridity?

In the first place the atypic sperms of molluscs are not of the same nature as those of moths, for in the case of moths the appearance of atypicality is during the maturation stages. The spermatocyte which will give rise to the atypic sperms has not yet been distinguished cytologically from one which will give rise to normal sperms.

So far as the atypic sperms of prosobranch mollusca are concerned, quite a different condition holds good. Some years ago it was shown (Quart. Jour. Micr. Science, vol. 63, p. 421) that apart from the then known fact that the atypic and typic spermatocytes were cytologically distinguishable, it was possible to trace back these two sorts of cells to two different kinds of germinal epithelial cells. In the primary spermatogonium of the atypic series, the mitochondria were granular, while those of the typic series were sausage- or rod-shaped—a difference which I showed to hold good through growth stages and maturation divisions. It seems clear that the atypicality of the sperms of some molluscs is a quality deep-seated in certain germ-cells, while that of some moth sperms is possibly merely traceable to abnormalities in metabolism due to the rapidly changing conditions during histogenesis.

Now with regard to Dr. Lotsy's query as to whether the atypicality of mollusc sperms is evidence as to hybrid ancestry, it may be mentioned that in Pulmonata Mollusca, the mitochondria are always granular in the spermatocytes, while the atypic spermatocytes of prosobranch Mollusca alone are granular, while those of the typic are sausage-shaped.

I leave an interpretation of this important fact to Dr. Lotsy or his opponents. One more word—these differences in the mitochondria of the two kinds of spermatocytes of Paludina can be seen *intra vitam* in freshly teased out cells.

J. BRONTË GATENBY.

University of Dublin, November 26.

A Simple Micro-barograph.

READERS of NATURE may be interested in a simple form of differential barometer by means of which changes in air pressure as small as one part in a hundred thousand may be readily observed. The apparatus consists of a vacuum flask to the mouth of which is fitted a two-holed cork. One hole bears a capillary tube and the other a small tube provided with a tap.

A small drop of liquid is introduced into the capillary, and with the tap B open, it can be made to occupy any desired initial position. Tap B is now closed, and the movements of the drop A following

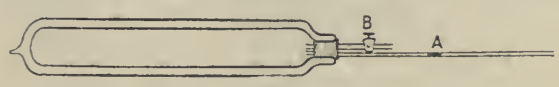

FIG. 1.

the changes in volume of the enclosed gas will indicate very small changes of pressure. The capillary, of course, must be kept level during the observations.

Using a vacuum flask of capacity 450 c.c., a capillary of 0·3 sq. mm. cross-section, and a drop of light paraffin oil as the liquid, the writer was able to demonstrate the changes of atmospheric pressure which occur during a change of vertical height of 1 ft.

The instrument was primarily designed for the purpose of demonstrating change of atmospheric pressure with height, and should be of use to teachers to demonstrate this phenomenon.

It would be interesting to know whether such an instrument has other applications. It may prove of interest to meteorologists for observing minute changes of atmospheric pressure during small time-intervals, and possibly also to aviators if set up in a less sensitive form. A. WECHSLER.

Hackney Technical Institute, London.

Scientific Workers in Russia.

MANY British scientific workers have acquaintances and friends among Russian men of science, and as Christmas is approaching they may wish to send a Christmas greeting which will support their colleagues during the hardest time that Russian science has ever had to endure. The American Relief Administration (67 Eaton Square, London, S.W.1) receives contributions in money, and from its famine relief stores in Russia will guarantee to deliver a parcel of foodstuffs to any person designated and will forward a receipt from the latter.

If a difficulty is found in selecting a particular Russian scientific worker, the parcel may be addressed simply to the Rector of the University of the city in question or to the President of the Military Medical Academy at Petrograd or the Academy of Sciences for distribution among the men of science of the respective institutions.

If necessary, I can furnish information about a number of Russian scientific workers.

V. KORENCHEVSKY.

Lister Institute of Preventive Medicine,
Chelsea, London, S.W.1.

The Maintenance of Scientific Research.[1]

By PROF. C. S. SHERRINGTON, Pres.R.S.

BROADLY taken, the apparatus of prosecution of research in this country is made up as follows: (1) Scientific and professional societies and some institutions entirely privately supported; (2) universities and colleges, with their scientific departments; (3) institutions, using that term in the widest sense, directly subventioned by the State, such for instance as the Medical Research Council, the Development Commission, and the Department of Scientific and Industrial Research. Of these three categories, the first named, the scientific societies group, works without financial aid from the State, apart from the small though extremely useful two Government grants distributed, mainly to individual workers, through the Royal Society. At the present time many of the societies sorely need financial help to carry on their labours, and some are absolutely at a loss to know how to publish the scientific results that are brought to them. The second category, the universities and colleges, depends in part upon Government aid. In the aggregate of twenty-one institutions of university rank, following Vice-Chancellor Adami's figures, students' fees and endowment provide about 63·5 per cent. of the total income; for the rest they are dependent on Government grant. The third category, as said, draws State-support direct.

This triple system may seem a somewhat haphazard and inco-ordinate assembly. Yet in reality it is an organisation with much solidarity, and its co-ordination is becoming more assured. Its parts dovetail together. The first group, the scientific and professional societies, is provided with a medium of intercommunication and co-action, the Conjoint Board of Scientific Societies. As to the separate categories composing the triple system itself, they also are in wide touch one with another. Between the scientific and professional societies on one hand and the universities on the other, contact and inter-relation are secured by some degree of free and rightful overlap, both as regards general subject-matter of research and of their *personnel*. Finally, there is excellent contact between both these categories and the third, the State subventioned institutions. A special feature of the policy and administration of these State organisations secures this, a feature which makes the whole of this subject the more cognate to the purview of our own Society. To exemplify I may turn, for instance, to the Development Commission. Its programme of fishery research, avoiding the terms "pure" research and "applied" research in view of the possible implication that pure research does not lead to practical result, directs research not alone to the solving of particular economic problems. It supports more especially what it terms "free" research, investigation in this case of the fundamental science of the sea and of marine life.

Again, with the Advisory Council of Scientific and Industrial Research, its programme, gradually defined during the past six years, is laid down as having four main points: (1) the encouragement of the individual research worker, particularly in pure science; (2) the organisation of national industries into co-operative research associations; (3) the direction and co-ordination of research for national purposes; and (4) the aiding of suitable researches undertaken by scientific and professional societies and organisations. It recruits researchers by giving financial opportunity to promising students to be trained in research, attaching them to experienced researchers. In short, it apprentices to research a number of selected younger workers in universities, colleges, and other institutions scattered throughout the country.

So, similarly, the Medical Research Council. Its secretary, Sir Walter Fletcher, in an illuminating presidential address to Section I of the British Association meeting this summer, said, speaking of the nexus between scientific research and the progress of medicine, "It is the accumulating knowledge of the basal laws of life and of the living organism to which alone we can look for the sure establishment either of the study of disease or of the applied sciences of medicine."

It is evident, therefore, that, with a policy based on such principles as these, the third category in the triple system constituting the organisation for scientific research in this country is one which has common aim and solid touch with both the others, the universities and the scientific and professional societies. One sees in short that the organisation which has come into existence and is maintaining scientific research in this country is a real organisation. It did not spring fully equipped from the head of Zeus. It has grown up rather than been planned. In that respect it is an organisation essentially British, and it seems qualified to do its work for the country well. We hear of adventures, political and other, the offspring of the day. But these were no adventures, these, to my mind, welcome, long-overdue steps forward by the State toward the succour of science and its welfare, steps that help to strengthen and consolidate the organisation for research by such adjuncts as the Medical Research Council and the Department of Scientific and Industrial Research. One of the strengths of this organisation that has arisen is, in my view, that it interlocks with the educational system of the country. It is an organisation which proceeds on the wise premiss that, in the case of science, the best way to get the fruit is to cultivate the tree. It is an organisation which is

[1] From the presidential address delivered to the Royal Society at the anniversary meeting on November 30.

proving successful and economical. Its output has proved a more than liberal return on the funds at its disposal.

But essential to its continuance is continuance of adequate financial support from the Government. A tripod cannot stand upon two legs. The State-contribution in this country is relatively not large, but it is most important. Important as it has been in the past, it has now an importance most especially great. The cost of investigation is now higher, much higher than it has been. Endowment funds carry less far than they did carry. Private benefactions and voluntary generosity, although willing, are less able to be found and less capable at this time; already gauged as inadequate of themselves alone before the war, they obviously cannot alone cope with the necessary undertakings now. The present is a time when a large-scale withdrawal of the Government's financial support must prove most formidably crippling. Such crippling will be greater than the actual measure of the sum withdrawn would entail in ordinary times.

To pull down under emergency what has been built up through years of careful experience and is proving efficient can scarcely be ultimate economy. It is to unlearn a useful lesson learnt. Curtailment of the State aid—relatively small in this country—given to scientific research must harm the scientific production of the country. Some curtailment, however, at this time seems unavoidable. Though extension of buildings and equipment and *personnel* is wanted, it may be necessary to withhold that extension at this time, maintaining broadly the *status quo* ready for expansion when that is once more feasible. But if research be an indispensable factor in the rebuilding of the national life, sacrifices should not be required from it disproportionately greater than from other services of a similarly essential kind. Reduction of the State's support on a scale to entail ruin to the existent organisation would be a wastage rather than an economy. Calmly viewed, what more reminiscent of the wastage of the war itself than for machinery actually constructed, assembled, and producing what is needful for a nation's strength as a pillar in the industrial and intellectual temple of the world, to be now under temporary change abandoned or broken up; and at a time when industry as a whole stands convinced of scientific research as a necessity for its recovery and well-being.

My hope would be that scientific research on its present maintenance will be considered part of the intellectual bread of the community, part of the bed-rock on which rests the efficiency, not to speak of the industrial equipment, of the nation; that it will be treated as such in the measure of State-support continued to it; that the State will remember that that support has to embrace at least both the universities on one hand, and, on the other, the research institutions administered by the State, for this reason, namely, that the country's organisation for research, complex in origin, yet economical and effective, stands as an integral system to the entire existence of which is essential an adequate State provision for both these constituent elements, indispensable, since they are, to the whole structure of the system.

The Rayleigh Memorial.

THE UNVEILING IN WESTMINSTER ABBEY.

THE history of the Rayleigh Memorial is soon told. Shortly after Lord Rayleigh's death in 1919 the desire was expressed by many of his friends to commemorate him in some suitable manner, and a committee was formed, with Sir J. J. Thomson, then president of the Royal Society, as chairman, to give effect to this wish. The committee contained representatives of the University of Cambridge, of which Lord Rayleigh was chancellor, as well as of the Royal Society.

After consideration it was decided that, subject to the permission of dean and chapter, a memorial tablet should be placed in Westminster Abbey, while his work at Cambridge as Cavendish professor should be commemorated by the promotion of research in some branch of science in which he was interested.

The dean and chapter gave a cordial assent to the wishes of the committee, and a position was chosen for the tablet on the north wall of the north transept close to the memorials to Sir Humphry Davy and Dr. Thomas Young. No space could be found near the group of medallions described in Commander E. C. Smith's interesting article in NATURE of December 1 which form the memorials to Adams, Stokes, Hooker, Wallace, Darwin, Lister, and Joule, but Lord Rayleigh's work had close connection with that of both Young and Davy; much of it was a distinct outcome of the researches of Young, and the position selected is most suitable.

Lord Rayleigh's friends are greatly indebted to Prof. Derwent Wood, R.A., for the tablet shown in the accompanying illustration and especially for the very excellent likeness of Lord Rayleigh, their "unerring leader in the advancement of natural knowledge," which he has executed.

The ceremony on November 30 was a very simple one. A number of Lord Rayleigh's relatives and friends assembled in the Abbey and were met by the dean and Canon Barnes. After two short prayers the dean invited Sir Joseph Thomson, the chairman of the committee, to unveil the tablet. When this was done the memorial was dedicated by the dean and, as a tribute to Lord Rayleigh's work and position, an address, which is subjoined, was delivered by Sir Joseph. The ceremony was then closed with the Benediction.

The following members of Lord Rayleigh's family and representatives of the University of Cambridge, the council of the Royal Society and other institutions with which he was connected were among those who were present:—

The Dowager Lady Rayleigh, Lord and Lady Rayleigh, Mrs. Sidgwick, the Hon. R. Strutt, the Hon. Edward and Mrs. Strutt, the Rt. Hon. G. W. and Lady Betty Balfour, and Mr. E. J. Strutt; the vice-chancellor of the University of Cambridge, Sir Joseph Larmor, and Mr. J. F. P. Rawlinson, Members of Parliament for the university; the president of the Royal Society, Sir J. J. Thomson, Sir David Prain, Mr. W. B. Hardy, Mr. Jeans, Sir Arthur Schuster, Prof. Lamb, Sir William Bragg, Prof. Fowler, Prof. O. W. Richardson, Sir Gerald Lenox Conyngham, members of council of the Royal Society; and Prof. F. Derwent Wood, Lord Southborough, Sir James Dewar, Sir William McCormick, Sir Charles Parsons, Sir George Beilby, Sir Oliver Lodge, Sir Maurice Fitzmaurice, Sir Napier Shaw, and Sir Richard Glazebrook.

JOHN WILLIAM STRUTT OM PC
3RD BARON RAYLEIGH
1842—1919
CHANCELLOR OF THE UNIVERSITY OF CAMBRIDGE 1906-1919
PRESIDENT OF THE ROYAL SOCIETY 1905-1908
AN UNERRING LEADER IN THE ADVANCEMENT OF
NATURAL KNOWLEDGE

Photo] [*F. Hilaire d'Arcis*

Memorial tablet of Lord Rayleigh by Prof. Derwent Wood R.A., unveiled in Westminster Abbey on November 30.

In order to promote research in a branch of science in which Lord Rayleigh was interested, it has been arranged to hand over the balance of the fund, some 500*l.* in amount, to the University of Cambridge to be used as a library fund at the Cavendish Laboratory, where there is a research library to the formation of which Lord Rayleigh contributed when professor. To have an annual sum available for the purchase of periodicals, binding, etc., would, in the opinion of both Sir J. J. Thomson and Sir Ernest Rutherford be of real service and would greatly promote research in physics at Cambridge.

Sir Joseph Thomson's Address.

On behalf of the Royal Society and of the University of Cambridge it is my privilege to thank the Dean and Chapter of Westminster for permission to erect a memorial to Lord Rayleigh in the Abbey. I desire also to thank the artist, Mr. Derwent Wood, whose skill has made the memorial an excellent likeness of Lord Rayleigh, and has endowed it with artistic merits which make it worthy of a place on these walls. I desire also to thank the contributors whose generosity has made this memorial possible. I owe my position here this afternoon to the courtesy of the president of the Royal Society, and of the vice-chancellor of the University of Cambridge. Either of these would have been a more appropriate representative than myself, but it is their wish that, as chairman of the Committee of the Memorial, I should undertake this duty. It seems fitting that, on this occasion, when we place a memorial to Lord Rayleigh in a building surrounded by memorials of the most illustrious of Englishmen, a few words should be said as a tribute to his work and in support of his claim to be represented on these walls. Lord Rayleigh devoted a long life with entire singleness of purpose and pre-eminent success to the pursuit of what, in the phraseology of the Royal Society, is called "the promotion of natural knowledge." For fifty years, without pause and without hurry, he pursued researches which are one of the glories of English science. It is possible to form an estimate of the quality and quantity of Lord Rayleigh's work by those six volumes of collected papers which we owe to the enterprise of the Syndics of the Cambridge University Press. Among the 446 papers which fill these volumes there is not one that is trivial, there is not one that does not advance the subject with which it deals, there is not one that does not clear away difficulties; and among that great number there are scarcely any which time has shown to require correction. It is this, I think, which explains that while the collected papers of scientific men often form a kind of memorial tablet in our libraries, respected but not disturbed, those of Lord Rayleigh are among the most frequently consulted books in the physicist's library.

The first impression that we gain on looking at these volumes is the catholicity of Lord Rayleigh's work—mathematics, light, heat, electricity, magnetism, the properties of gases, of liquids and solids, are all represented in fairly equal proportions. If I were asked to explain in what department of physics Lord Rayleigh's work was most important I should be quite at a loss to do so. In these days when we speak of electricians, of molecular physicists, elasticians, or even if we take the wider classification

of mathematical physicists and experimental physicists, it is refreshing to come across one who was each—who, like Kelvin and Stokes, was each and all of these. Lord Rayleigh took physics for his province and extended the boundary of every department of physics. The impression made by reading his papers is not only due to the beauty of the new results attained, but to the clearness and insight displayed, which gives one a new grasp of the subject. No subject passed through Lord Rayleigh's mind without being clarified and having its difficulties either removed or brought so strongly into the light as to be subject to attack on every side.

The impression that one gets after reading a paper by Lord Rayleigh is that the subject, if I may use a homely phrase, has been tidied-up. Law and order have been substituted for disorder. There are some great men of science whose claim consists in having said the first word on a subject, in having introduced some new idea which has proved fruitful; there are others whose claim consists perhaps in having said the last word on the subject, and who have reduced the subject to logical consistency and clearness. I think by temperament Lord Rayleigh really belonged to the second group. Certainly no man ever revelled more in that greatest of intellectual pleasures, working at a subject which was all obscured and tangled and bringing it to a stage where everything was clear and in order. When we take Lord Rayleigh's papers we find some purely mathematical, in which, with his characteristic directness of attack and simplicity of means, he obtained most important results. We get others almost purely experimental, such as the determination of the absolute unit in electricity, in which, again, with simple apparatus, he attained results which rivalled in accuracy those of Regnault and Joule. But in the majority of writings we have a combination of mathematical analysis and experimental work, and his papers, I think, afford the best illustration of the true co-ordination of those two great branches of attack on the problems of nature. The physical ideas direct the mathematical analysis into the shortest and most appropriate channels, while the mathematics gives precision and point to the physics.

Just one word about another characteristic of Lord Rayleigh. He was, so to speak, the knight-errant of physics. There are men of whom it is said that they never shirk a difficulty, but Lord Rayleigh went roaming about seeking for difficulties to destroy, and I really believe that he loved a difficulty for its own sake, and perhaps felt sorry for it after he had destroyed it. But among the difficulties in physics none was ever created by any default of Lord Rayleigh in clearness of expression or clearness of thought. He was an artist in the production of his papers. He had the artist's instinct ingrained so deeply that even the excitement and hurry of the Cambridge Mathematical Tripos in the old days, when it was literally a race against time, could not destroy it. Every one of his examiners on that occasion said that his papers were so clear that they could have been sent to press without revision.

Among Lord Rayleigh's many discoveries I will just confine myself to one, the discovery of argon, because that is the one which attracted most attention, and in which, perhaps, he broke the newest ground. The discovery of argon is one of the romances of science. The fact was that we had, unsuspected among us, the element in large proportions—there are, I believe, some tons of it within the walls of this building—and yet, in spite of the experiments of chemists and physicists for centuries no suspicion of its existence had ever arisen. It seems rather an irony that while the chemists had been ransacking mines and searching the stars for new elements, all the time there had been in their laboratories an element with more remarkable properties than any that had been discovered. The remarkable thing about Lord Rayleigh's investigation was that it was not because he used instruments more powerful than any of those at the command of his predecessors. Argon was tracked down by the oldest piece of chemical apparatus, the balance, an instrument which had been at the command of all Lord Rayleigh's predecessors, and by which they might have made the discovery, but they did not. In the isolation of argon Lord Rayleigh was fortunate enough to procure the co-operation of Sir William Ramsay, and when the properties of the new substance were investigated they turned out to be of extraordinary interest, and the discovery of this, which was followed by the discovery of other gases of the same nature, has had a very pronounced influence on the progress of our ideas as to the structure of matter.

I must pass on from Lord Rayleigh's contributions to science to consider some of his public services. He was long and intimately connected with the Royal Society. For nine years he was secretary, and for three years he was president. He enriched the publications of that society by papers which added greatly to its prestige. He rendered great services to the University of Cambridge. On Maxwell's death in 1879, when the success of the new School of Physics was not yet assured, Lord Rayleigh, at considerable personal sacrifice, came to the rescue, and for five years he was the Cavendish Professor of Physics, and this work, with the assistance of that of Sir Richard Glazebrook and of Sir Napier Shaw, put the school on such a firm basis that its success has never since been in doubt. The University took the opportunity of honouring Lord Rayleigh by making him their chancellor; but it was not only work that Lord Rayleigh gave to the University: he was a generous benefactor. When he received the Nobel prize he handed over the money for the use of the University. Again, he was long connected with the Royal Institution. He was professor there for seventeen years, and many of us have heard those clear explanations of some of the most difficult problems of physics, accompanied by experiments, which were characteristically simple and beautiful.

But of all the bodies with which Lord Rayleigh was associated I doubt if there was one in which he was more interested than in the National Physical Laboratory. He was the chairman of the committee which recommended the foundation of that institution, and he was chairman of the executive body from the beginning until a year or two before his death. The growth of that institution from very small beginnings to the position it now occupies, that of the most important institution of its kind in the world, is due in no small degree to the work that Lord Rayleigh gave to it, to the judgment that he displayed in conducting its affairs, to his knowledge, and to his influence.

Another subject in connection with which Lord Rayleigh rendered great services was that of flight. He was convinced long before other people of the possibility, and even the probability, of flight, and when flight became a serious problem to this country he became chairman of the Committee on Research in Aeronautics, and it meant everything to that sub-

ject, perpetually perplexed with new problems, to have at its command the unerring judgment of Lord Rayleigh and his knowledge of theory and his keen instinct for practice. During the war, when any specially important or specially difficult point arose in connection with the application of science for the use of the Army or Navy, Lord Rayleigh was very often consulted, and never in vain. Lord Rayleigh, I believe, has had every honour that this country can bestow, and he deserves that place on the walls of the Abbey close by the memorials to Davy and to Young, for, like them, he increased the prestige of this country in science, and widened the bounds of our knowledge of nature.

International Physico-chemical Symbols.

By PROF. ALEX. FINDLAY.

IN the years prior to the war endeavours were made by various internationally constituted bodies to secure greater uniformity in the symbols used in different countries and by different writers to represent physical, physico-chemical, and electrotechnical quantities. As part of the general movement to this end the International Association of Chemical Societies, founded in 1911, set up a Commission for the Unification of Physico-chemical Symbols, and in 1913 this commission submitted to the council of the International Association of Chemical Societies a list of symbols for quantities especially of physico-chemical importance. At this point, however, the need was felt for co-ordinating the work of the commission with that of other bodies, and a small "working committee," consisting of Sir William Ramsay (chairman), Dr. Friedrich Auerbach, Profs. P. A. Guye, P. J. Walden, and Alex. Findlay (secretary), was therefore set up in order to secure this co-ordination and to suggest methods of organisation and work.

The list of symbols drawn up by the Commission for the Unification of Physico-chemical Symbols was submitted for consideration and criticism to the chemical societies of the different countries represented on the International Association, to the Ausschuss für Einheiten und Formelgrössen, and to the International Electrotechnical Commission. The criticisms and suggestions received from these bodies were considered in May, 1914, by the working committee to which reference has been made above, and a list of symbols was then drawn up for the approval of the International Commission. Unfortunately, however, before the meeting of the International Commission took place, international scientific relations were ruptured by the outbreak of war, and the list of symbols recommended unanimously by the members of the working committee could not, therefore, receive the approval of the parent commission. As it is not to be doubted that this approval would have been given, and as it would have been a misfortune if the labours of the committee on which Great Britain, France, Germany, Russia, and Switzerland were represented had been in vain, the council of the Chemical Society, with the approval of the recently constituted International Union of Pure and Applied Chemistry, authorised the publication of the committee's report and list of symbols in the Transactions of the Chemical Society, April, 1921.[1]

As regards the general principles adopted by the working committee it may be said that in drawing up its list the committee restricted itself to symbols for quantities of chemical or physico-chemical importance and approved the general principle adopted by the International Commission that Greek letters should be used as sparingly as possible. In respect of symbols for quantities used, especially in mathematics, physics, and the various branches of mathematics and physics, the committee restricted itself to *noting* the symbols which had been recommended or adopted by the scientific bodies specially interested in these quantities, and there were included in the committee's list only those symbols about which there was general agreement among the specially competent bodies. As it was not possible, in the case of symbols which are employed in different branches of pure and applied science, always to obtain agreement among the representatives of different sciences, the committee adopted the symbols which find, or are likely to find, general acceptance by chemists or physico-chemists.

Although a practically universal agreement already obtained regarding many of the symbols, there were a number of quantities for which diverse symbols were employed by different writers or were suggested by various bodies. It was necessary, therefore, for the committee to examine, carefully and critically, the different suggestions and to make a decision as to the symbols to be recommended for use. The reasons for the choice of symbol made by the committee in the debated cases are appended to the list of symbols.

Although it is not possible to refer specifically to all debatable cases, reference may be made to a few important quantities. For entropy and for maximum work the committee recommends the symbols S and A respectively, although in doing so regret is expressed at having to depart from the classical symbols ϕ and ψ employed by Willard Gibbs. The committee, however, states that it felt such departure to be advisable on the twofold principle of disturbing existing usage as little as possible and of employing Greek letters as sparingly as possible. For degree of dissociation

[1] Copies of the report and list of symbols may be obtained on application to the Assistant Secretary of the Chemical Society, Burlington House, London, W.1.

(ionic, thermal, etc.) the committee recommends the symbol α; for the ratio of specific heats the symbol γ; and for electrode potential, as for electromotive force, the symbol E. It may also be noted that the committee recommends that kation should always be spelt with a "k."

While the committee considered it to be inadvisable that any attempt should be made to compel authors to use the symbols which it recommends, it was of opinion that every means should be taken to encourage the use of these symbols, and it remains for the different official bodies concerned to consider how such encouragement can best be given.

Obituary.

DR. J. A. ALLEN.

MR. H. E. ANTHONY, associate curator of mammals in the American Museum of Natural History, New York, has sent us a detailed notice of the life and scientific work of DR. J. A. ALLEN. Lack of space prevents us from publishing more than the following extracts referring to a few points of particular interest:—

Natural history has suffered a heavy loss by the death, on August 29 last, of Dr. Joel Asaph Allen at eighty-three years of age. Dr. Allen was best known for the work in mammalogy which he carried out as curator of ornithology and mammalogy in the American Museum of Natural History of New York City. However, his activities were manifold, and an insight into the truly remarkable amount of work accomplished by Dr. Allen may be gained from a glance at his bibliography, which in 1916 included the following: Papers on mammals, 271; on birds, 966; on reptiles, 5; on zoogeography, 9; on evolution, 22; on nomenclature, 35; on biography, 134; miscellaneous, 20; a total of no less than 1462 papers. Since the publication of this list other papers have appeared and a great deal of unpublished manuscript has been prepared for publication. One could not but be impressed by such a list as a mere feat of writing alone, but the workers in his field who consult the publications of Dr. Allen know that an infinite amount of patience, of painstaking application to tiring detail, and of well-balanced and judicious weighing of facts, is characteristic of his papers.

The bulk of Dr. Allen's papers deal with taxonomic questions, with the identification of collections and with the revision of groups. Many of the latter have become classical, and among the best-known might be mentioned the monographs on North American Rodentia, written in collaboration with Dr. Elliot Coues. Dr. Allen had marked capabilities for philosophical research into, and interpretation of, the phenomena of zoology, as is well shown by some of his earlier papers, but circumstances directed that he should expend his energies in other directions.

One of his youthful aspirations was for editorial work, and from 1874, when he edited his first "Proceedings of the Boston Society of Natural History," until 1918 he performed continuous service as editor of several scientific publications. For thirty-two years of this period he edited the Bulletin of the American Museum of Natural History, and for twenty-eight years the *Auk*.

Probably Dr. Allen is best known internationally through his authoritative position on zoological nomenclature. In this exacting field he was pre-eminent; internationally his worth was recognised by his position on the International Commissions since 1910.

Among the many honours which Dr. Allen received may be mentioned the Walker Grand Prize of the Boston Society of Natural History in 1903, and the medal of the Linnæan Society of New York in 1916; he was president of the American Ornithologists' Union, 1883–91, president of the Linnæan Society of New York, 1890–1897, member of the National Academy of Sciences, etc. He was also an honorary member of the British Ornithologists' Union, the Zoological Society of London, the Australian Ornithologists' Union, and the South African Ornithologists' Union.

The early part of Dr. Allen's life was spent in New England. That part of his academic training which had most influence upon his later life was his association with the great teacher, Louis Agassiz. Struggling under the handicap of a constitution at no time very strong, he made several notable collecting trips, the most important being that to Brazil in 1865. His first museum appointment was with the Museum of Comparative Zoology at Cambridge, Massachusetts, but in 1885 he took a curatorship in the American Museum of Natural History of New York City. Here his tenure was continuous until the time of his death.

Dr. Allen numbered among his friends practically all the well-known workers on birds and mammals, and the respect for his scientific attainments promptly grew into a love of the man himself whenever one was fortunate enough to be numbered among his personal friends.

W. A. BAILLIE-GROHMAN.

IT is with much regret that we record the death of Mr. W. A. Baillie-Grohman, who passed away suddenly on November 27 at Schloss Matzen, in Tyrol, in his seventy-first year. A man of striking physique, endowed with high courage and great mind, he possessed an intense affection for the wild and grand in Nature, coupled, remarkably enough, with an unflagging interest in much that is purely scholarly. That such a man, the son of a sporting Austrian of large estate, should have developed in early youth what proved to be permanent tastes for hunting and mountaineering was perhaps inevitable, and in due course his adven-

tures upon the mountains of Europe and North America gained for him a great reputation both as an intrepid climber and as a shooter of big game. But his claim to be remembered by naturalists rests upon a far more secure foundation, for many who achieve distinction in the fields indicated are, perhaps, best forgotten.

Most fortunately, Baillie-Grohman soon began to write about his favourite pursuits, and from 1875 onwards many books and innumerable articles in periodicals flowed from his pen. In these writings there is much of interest and importance to the naturalist, for the author was keen-sighted as well as judicious. His love of the chase led him to examine everything connected with its history, and with the utmost patience and industry he explored ancient books, pictures, tapestries, and mouldering heaps of medieval records in search of facts. The results of these researches are well seen in what is probably Baillie-Grohman's greatest book, "Sport in Art" (1913), which is, in effect, an admirable history of the chase as practised in the four centuries between 1400 and 1800. Of even greater interest are his two editions of "The Master of Game," written by Edward, second Duke of York (Shakespeare's "false Aumerle"), between 1406 and 1413. This work, comprising a translation of Gaston de Foix's "Livre de Chasse" (*circa* 1390), and five original chapters on English hunting, is the oldest book of hunting in our language, and as such must always make a special appeal to the student of British mammals.

By the death of Mr. R. W. Frazer, at sixty-seven years of age, India has lost a learned philologist and student of its literature and philosophy. Joining the Madras Civil Service in 1877, he was invalided in 1881 as the result of exposure on famine duties and service during a local disturbance in the Godavari Hills. On his retirement he became librarian of the London Institution, and it was by his initiative that it was absorbed by the School of Oriental Studies. Frazer lectured extensively on subjects connected with Southern India, and acquired a seldom-rivalled knowledge of Tamil and Telugu. He will be best remembered by his "British India" in the "Story of the Nations" series, his "Literary History of India," and "Indian Thought, Past and Present." He was for a short time secretary of the Royal Asiatic Society, succeeding Miss Hughes, who became his wife, and survives him.

Notes.

The anniversary meeting of the Royal Society was held on St. Andrew's Day, November 30, and the following officers were elected:—*President:* Prof. C. S. Sherrington. *Treasurer:* Sir David Prain. *Secretaries:* Mr. W. B. Hardy and Mr. J. H. Jeans. *Foreign Secretary:* Sir Arthur Schuster. *Other Members of Council:* Sir Frederick Andrewes, Prof. V. H. Blackman, Sir William Bragg, Prof. A. W. Crossley, Dr. H. H. Dale, Prof. A. S. Eddington, Prof. A. Fowler, Prof. A. Harden, Prof. J. Graham Kerr, Prof. H. Lamb, Sir William Leishman, Sir Gerald Lenox Conyngham, Lord Rayleigh, Prof. O. W. Richardson, Sir Aubrey Strahan, and Prof. J. T. Wilson. Prof. Sherrington delivered the anniversary address, which is abridged on p. 470 of this issue, and presented the medals as follows:—The Copley Medal to Sir Joseph Larmor, who has long held a leading position in the British school of mathematical physics. It may fairly be said that his preliminary work was of the utmost value in paving the way to the modern developments of the theory of relativity. A Royal medal to Dr. Frederick Frost Blackman, distinguished for his contributions to plant physiology, and especially to knowledge of the process of photo-synthetic assimilation of carbon dioxide. A Royal medal to Sir Frank Dyson, who has devoted special attention to investigations of the movements and distances of the stars and of the bearing of these upon the structure of the stellar universe. It was mainly to his foresight and organising ability that we owe the successful observations of the deflection of light by the sun's gravitational field during the eclipse of 1919. The Davy medal to Prof. Phillipe Auguste Guye, in recognition of his work on optically active organic substances, on molecular association, and on atomic weights. The Hughes medal to Prof. Niels Bohr, the author of the conception to which the name "Bohr-atom" has been attached. This conception gave a solution of the long-standing puzzle of the Balmer series of hydrogen, and appears likely to provide a complete explanation of the spectra of the various elements.

At the meeting of the Royal Geographical Society held on Monday, December 5, the president announced that it is hoped the members of the Mount Everest Expedition will have returned by the end of this week. Messrs. Raeburn and Mallory are already home, and Col. Howard Bury and Messrs. Wollaston and Bullock are on their way. The natural history collection and the photographic plates have also arrived, and the maps will be here within the next fortnight. It is satisfactory to find that the collections have reached home in excellent order. There is a plant belonging to the pink family from a height of 20,400 ft. above sea-level, and there are several kinds of primula—pale yellow, blue, and dark purple—and one with big hanging bells, and many gentians, a remarkable yellow *Pedicularis delphinium*, and some beautiful dwarf rhododendrons. One hundred and sixteen packets of seed in excellent condition are among the treasures which have reached the Royal Geographical Society, of which eighteen packets are of rhododendrons, twelve of primulas, eighteen of meconopsis, and four of gentians. From a height of 19,000 ft., the highest point from which seeds were obtained, is a packet of edelweiss. Then there is a sparrow from 18,500 ft.,

larks of various species, including a very large calandra lark which may perhaps be new, wagtails, white-headed robins, a chough and cuckoo, rose-finches, bullfinches, and—of fine omen—a blue bird. There are also boxes of birds' eggs, numerous butterflies and moths, and other insects, including bees and fleas, frogs and fishes, and a few mammals. These are all now at Kew and the Natural History Museum being identified and distributed. The photographic plates, all developed, have arrived without a single breakage, and the number of photographs the society now has is more than six hundred. A selection of the best will be exhibited to the public in the Alpine Club Gallery in the middle of January.

DR. NIELS BOHR (Copenhagen), Dr. Johan Hjort, head of the Norwegian Fisheries, and Prof. Paul Langevin (Paris) have been elected honorary members of the Royal Institution.

THE American Association for the Advancement of Science will meet in Toronto on December 27–31 in the University buildings. The Royal Astronomical Society of Canada will meet at the same time and assist in the programme of the Association.

THE Paris correspondent of the *Times* announces that M. Georges Claude, who has been awarded the Prix le Conte of 50,000 francs (1000*l.*) by the Academy of Sciences for his work in chemistry and physics and the practical application of the results to industry, has requested the Academy to devote one-half of the amount to the Société de Secours des Amis des Sciences and the other half to the research laboratories of the Collège de France.

PROF. HORACE LAMB, Sir Ernest Rutherford, Sir Arthur Schuster, and Prof. G. Elliot Smith have been elected honorary members of the Manchester Literary and Philosophical Society. Dr. H. F. Coward has been elected chairman of the chemical section of the society for the ensuing session.

A HIGHLY successful course of Swiney Lectures on Geology was completed on December 2 by Dr. J. D. Falconer at the Imperial College of Science, South Kensington. These lectures are delivered annually under the auspices of the trustees of the British Museum, and are designed to stimulate public interest in geological science. The average attendance for the twelve lectures was 261, a gratifying record to all concerned.

THE annual general meeting of the Decimal Association was held on November 30 at Stationers' Hall. Proposals for the adoption by the association of a step by step policy in dealing with weights and measures were made, and the following resolution was carried: "That this association, while adhering to the policy of adopting the metric system of weights and measures, recognises that its object can best be obtained in steps, and that the first step should be the dealing with weights."

THE Jamaica earthquake of January 14, 1907, so destructive to the city of Kingston, was followed by a number of after-shocks, of which nearly a hundred during the succeeding six months were strong enough to be registered in this country. Stronger than any of these after-shocks, or indeed than any earthquake in the island since 1907, was that which occurred on November 25 last. The shock was of short duration, but it was strong enough to crack the walls of some buildings.

UNDER the presidency of M. Millerand, President of the French Republic, a meeting was held at the Sorbonne, Paris, at 3 p.m. on November 24 to commemorate the centenary of Ampère's publication of his fundamental laws of electromagnetism. The President was supported by the chief Ministers of public Departments, and the Republican Guard under the direction of M. Balay played selections during the proceedings. Addresses were delivered by Prof. Berthelot, Appell, and Janet and by Messrs. Legouez, Boucherot, Mailloux, and Berard. During the following morning a reception took place at the Conservatoire des Arts et Métiers, and the new gallery of models of telegraphic and telephonic apparatus was opened. An Ampère medal is being struck as a souvenir of the occasion.

SINCE the advent of aviation visibility over the land has advanced from occupying a secondary position to one of major importance amongst subjects of meteorological investigation. During the past few years the matter has consequently been engaging the close attention of meteorologists, and much progress has been made in the taking of accurate observations. In order to allow a free exchange of opinions on the subject, the meeting of the Royal Meteorological Society to be held at 5 p.m. on December 14 will be devoted to a discussion on "Visibility." The discussion will be opened by Mr. F. J. W. Whipple, who will give a general introduction, while other speakers will approach the matter more particularly from the points of view of the airman, the seaman, and the physicist. The subject of London fogs will also be introduced. Those desirous of obtaining tickets for the meeting should apply to the Assistant Secretary of the Royal Meteorological Society at 49 Cromwell Road, South Kensington.

AT the monthly meeting of the Zoological Society of London held on November 23 twenty new fellows were elected to the society, eighty-seven candidates proposed for election as fellows, two as foreign members, and eight as corresponding members. The report of the council showed that 509 additions had been made to the society's menagerie during the quarter, including 165 by presentation, 182 by purchase, 98 by deposit, 29 in exchange, and 35 born in the gardens. Special mention is made of a collection of mammals, birds, and reptiles from New Guinea and Aru obtained by Mr. Frost, which included four species of birds-of-paradise and several rare doves and parrots new to the collections. The number of visitors during the quarter showed a decrease of 108,735 and the receipts a decrease of 844*l.* as compared with the corresponding period of last year. Two hundred and ninety-eight new fellows have been elected to the society since January 1. The society's silver medal was presented to H.E. Capt. C. H. Armitage, Chief Commissioner of the Northern Territories,

Gold Coast, for his many valuable gifts to the collections from 1904.

ON the arrival of the *Quest* at Rio de Janeiro Sir E. Shackleton announced a change in the plans of his Antarctic expedition. According to the *Times*, Rio de Janeiro instead of Cape Town will be the base of the expedition, and the *Quest* was to sail about December 5 direct to South Georgia, arriving there about Christmas Day and leaving at the New Year for Enderby Land *via* Bouvet Island. An attempt will be made to prove the existence or non-existence of Thompson Island, an island reported to lie in the vicinity of Bouvet Island, but probably identical with the latter. Bouvet Island has been visited only once, namely, by the *Valdivia* in 1898, since its discovery in 1739. No landing has been made, and the island is reported ice-covered and inaccessible. Sir E. Shackleton hopes to enter the ice about January 22, and after visiting Enderby Land, if the ice permits, to arrive again at South Georgia by the end of March. There the *Quest* will coal and sail for Tristan da Cunha and Cape Town. The change in plans was attributed to the delay due to contrary winds and the weakness of the auxiliary engines. New topmasts were being fitted in order to increase the spread of canvas and allow the vessel to be driven through the pack-ice under sail. On the voyage to Rio de Janeiro a call was made at St. Paul's Rocks, which no ship appears to have visited since the *Scotia* in 1902. It is not reported if landing was found to be possible.

THE benefits conferred upon the native races of India by the presence in their midst of an energetic body of irrigation engineers were admirably set forth in two articles, entitled "Canals of the Punjab," by Lieut.-Col. Aubrey O'Brien, which appeared in the *Daily Telegraph* for November 25 and 30. The articles dealt with the great irrigation schemes already carried out and those for which plans have been prepared. By the harnessing of the waters of the Jumna, Sutlej, Ravi, Chenab, and Jhelum the area of irrigated land within the Punjab has been increased since the Mutiny from half a million to more than ten million acres. Worked entirely for the benefit of the people of the Punjab, the canals already return to the revenues of the province a profit of 14½ per cent. on the capital spent on them, and this with the lightest of dues. The present value of crops on 10,000,000 acres is considered to be not less than 50,000,000*l*. Great as these achievements are, they bid fair to be surpassed in importance and interest by the schemes due to Mr. W. H. Ives, the Chief Engineer of the Punjab, one of which, the Sutlej Valley Project, aims at irrigating very large areas in British territory, and also in the native States of Bahawalpur and Bikanir. It is estimated that this scheme, which will cost some 14,000,000*l*., will irrigate 9,000,000 acres. On the completion of this it is proposed to carry out another large scheme where the Sutlej emerges from the hills. The river here runs for forty miles in a great loop, piercing a range 3500 ft. high, and then turning back almost parallel to its previous course. At the gorge of Bhakra a dam 395 ft. high—50 ft. higher than any dam at present in existence—will be built, impounding a volume of water about three times greater than that held up by the Assouan Dam on the Nile, and it is anticipated that by utilising the water for driving turbines, power can be obtained up to 300,000 horse-power.

THE Copper Eskimo of Coronation Gulf were studied by the recent Canadian Arctic Expedition. Mr. D. Jenness, the anthropologist of the expedition, gives an account of these people in the *Geographical Review* for October. Until 1838 these Eskimo, who inhabit Coronation Gulf, Union and Dolphin Straits, and Kent Peninsula, were practically unknown, and after that date they were seldom encountered until the Canadian Arctic Expedition visited them in 1914. Mr. Jenness says that he found them still practically in the Stone age, but changes have occurred in the last few years. Contact with European fur traders has led to the introduction of metal goods, rifles, changes in clothing and mode of life. The habits of the people are changing, and their greater success in hunting bids fair to exterminate the caribou. Mr. Jenness views with some concern the contact of civilisation with these Eskimo, and, by reason of scarcity of caribou and introduced white man's diseases, fears that before long they may dwindle to a degenerate remnant on the way to extinction.

A DEPLORABLE instance of misdirected energy is recorded in the November issue of *British Birds*, where Mr. W. Rowan, in the course of a most admirable account of the breeding haunts and habits of the merlin, tells us that on the two moors which formed the area of his investigations "it is but rarely that a hawk attempting to breed survives . . . to tell the tale." The moors in question—the Barden and Embsay moors—form a single stretch nearly twenty square miles in area. During nineteen successive years no less than nineteen pairs of merlin were killed on *one* nesting-site only—"one pair each year without a miss, and not a single egg was hatched." Moreover, it would appear that every one of these wretched birds was trapped. The annual average of breeding merlins on this moor appears to be three or four pairs; not a single pair succeeds, save perhaps by the merest accident, in escaping destruction. This lamentable state of affairs, we fear, can be remedied only by the help of the owner of the moor, and it is to be hoped that steps will immediately be taken to extend protection against this senseless and unwarranted persecution, for there is no justification for the implied game-destroying habits of these birds.

TO the *Lancashire and Cheshire Naturalist* for July–August Dr. J. Cosmo Melville contributes an interesting series of notes on the Sidebotham collection of Lepidoptera in the Manchester Museum. Very nearly all the British species are represented in the collection, and it contains fine series of many varieties, and also material of historical interest. The now extinct butterfly *Chrysophanus dispar* is represented by twenty-seven perfect specimens, and the very rare hawk moth, *Choerocampa celerio*, by five examples

with full data. There are two Staffordshire examples of *Leucodonta bicoloria*, and one of the two authenticated British examples of *Byrophila algae* is in this collection. In a brief article on the growth of the Manchester Museum Mr. T. A. Coward points out that that institution is now exceptionally rich in valuable collections; in fact, few provincial museums can vie with it in this respect. The famous Dresser collection of birds and eggs and the valuable ornithological library attached thereto are almost indispensable to serious students. In the botanical department of the museum are located the huge herbaria of Dr. Cosmo Melville and Mr. Charles Bailey, along with the Barker and other cryptogamic collections.

THE annual report of the Meteorological Office for the year ended March 31, 1921, has been submitted to the Air Council for the first time since the control has been taken over from the Lords Commissioners of His Majesty's Treasury. The period dealt with was a time of transition and reorganisation, an important change being the retirement of Sir Napier Shaw from the directorship after twenty years' service and the appointment of Dr. G. C. Simpson to the vacant position. Among the many changes made in the carrying on and extension of the work at its different centres of activity a considerable increase has been made in the staff employed. At the commencement of the year the clerical, technical, and unclassified posts numbered 182, and at the end of the year 213, leaving 65 vacancies to be filled to bring the staff to its required strength. There is a restriction that candidates must be drawn from ex-Service men. The Marine Division of the Office deals with the issue of meteorological and ocean-current charts, together with other weather information for the sailor. The Forecast Service, in addition to publishing the *Daily Weather Report*, is taking advantage of every opportunity to improve the value of the daily weather forecasts and harvest forecasts, a spell notification being issued for the latter when conditions are favourable for two or three days of fair weather. Climatological observations are issued in the *Weekly Weather Report* and in the *Monthly Weather Report*. The meteorology of the whole globe is also now regularly discussed. The British Rainfall Organization is being controlled by the Meteorological Office, and the publication of rainfall statistics for the British Isles occupies much time. Observations on the upper air also involve a large amount of work.

THE Faraday Society has issued as a separate pamphlet of 83 pages an account of the discussion on electro-deposition and electro-plating which took place at the joint meeting of the society and the Sheffield Section of the Institute of Metals in November, 1920. Of the recent improvements referred to in the papers read and the discussion which ensued, one of the most important is the electro-deposition of the water-jackets of aeroplane engines and the possibility opened out by this success of building up elaborate parts of machinery by the same process. The advantages of cobalt-plating have been recognised for twenty years, but it is pointed out that there is still difficulty in securing the perfect adhesion of thick deposits. The influence of colloids in the depositing tank on the properties of the deposit is still imperfectly understood, although it seems undoubted that their presence leads to a decrease in the size of grain deposited. The chairman and one of the speakers expressed regret that some of the authors of papers had not made themselves acquainted with the work of previous investigators before commencing their own experiments.

IN the *Chemical News* of October 28 Prof. B. Brauner, of Prague, discusses the official report of the International Commission on Chemical Elements (NATURE, August 18, p. 787). He cannot accept the principle that "exact atomic weights are now becoming factors of an analytical calculation rather than features of a chemical hypothesis." Prof. Brauner has also the support of another authority on atomic weight determinations, Sir Edward Thorpe, who in his presidential address to the British Association at Edinburgh, considered it of importance to "determine with the highest attainable accuracy the departures from the whole number rule." Prof Brauner raises the following questions: "Why do we find with our chemical processes and the balance that the *atomic weights* of the pure elements, C, N, P, S, are *larger* than their *atomic masses* [as found by the positive-ray method]; why those of As, I, and Cs are smaller, and why those of He, O, F, Na, are exactly equal to their atomic masses, or in other words, why is the hypothesis of Prout in its modern form valid for atomic masses, but only in four out of twelve cases for the corresponding atomic weights? Another interesting question arises: Why are Aston's isotopes, as far as we know, always mixed up in the same proportion?" In the *Philosophical Magazine* for October Sir E. Rutherford gives reasons for the value, 14·01 (adopted by chemists) rather than 14·00, found by the positive-ray method, and suggests that a refinement of the latter method might distinguish between the two values.

WE have received from Messrs. Kodak a forty-eight-page booklet, entitled "X-Rays," which they are distributing to the members of the medical profession. It explains in a clear way the funamental laws of practical importance that underlie the production and use of X-rays, giving, for example, the relationship between the length of the spark gap and the required exposure, and the quality of the negative. The development and other treatment of the exposed plate or film is dealt with at length. The special aim of the booklet is the standardisation of procedure, so that the uniformity of method shall simplify diagnosis.

SINCE the introduction of the steam turbine the question of the production of high-speed gear-wheels has occupied the attention of many engineers. Generally, the type of gear-wheels employed has been double-helical. In a paper read by Eng.-Lt.-Comdr. L. J. le Mesurier on November 22 before the North-East Coast Institution of Engineers and Shipbuilders, the Maag gearing is described and

the process of manufacturing it is explained. This gearing is of the straight-toothed type, and has been developed by the Maag Gear Co., of Zurich. Means have been found by which straight-tooth spur gears can be employed successfully under conditions demanding the highest possible peripheral speeds and loads per unit width of tooth. The methods of production ensure the requisite degree of accuracy, and at the same time provide a tooth form which is considered to give the most favourable conditions of sliding contact during engagement. A novel grinding process has also been devised whereby it is possible to generate a correct profile on a case-hardened tooth surface by means which are independent of the wear which must take place on the grinding disc. The compensating arrangements in the grinding machine are extremely interesting, and keep the grinding planes in their correct position to within ±1/1000 mm. The gear has been applied to several ships and to a large number of electrical plants and electric-locomotive drives.

"A WINTER GUEST," the seasonable and striking Christmas card published by the Royal Society for the Protection of Birds (23 Queen Anne's Gate, S.W.), represents the redwing, sometimes called the "Norwegian Nightingale," though known in England only as a winter visitor. The picture is reproduced in colour from a painting by Mr. H. Gronvold, and gives very happily the character and the appealing expression of the little traveller. It can be had, with calendar, for 5*d.* by post.

ERRATUM.—The Poets' Corner of Westminster Abbey is in the south transept, and not the north, as stated in the article on "Science in Westminster Abbey" in last week's NATURE, p. 437.

Our Astronomical Column.

THE EFFECTIVE WAVE-LENGTH OF THE LIGHT OF GALACTIC STARS.—Prof. O. Bergstrand contributes a paper on this subject to the centenary number of *Astron. Nach.* The research is based on a series of plates of the star-cloud in Cygnus obtained with a 15-cm. triple objective prism. The spectral types of the brighter stars were taken from the Henry Draper catalogue, and the following table shows the correlation between type and effective wave-length λ.

Type	λ	Type	λ	Type	λ
O	411$\mu\mu$	F	421	K	429
B	416	G	423	M	439
A	419	G_5	425		

Only two M stars were available, both probably giants. From the evidence of the G_5 and K stars, the author concludes that dwarfs have a smaller value of λ than giants of the same type.

An analysis is then given of the values of λ for the fainter stars down to magnitude 13·4. It is pointed out that the percentage of white stars is more than 60 for stars brighter than 11·4 m., and then drops suddenly to less than 50. He explains this by assuming that the white stars have the highest absolute brightness, and so are more distant than yellow or red stars of the same apparent magnitude. Hence we reach the limits of our local star system sooner in the white stars than in the yellow ones, causing a drop in the percentage for the fainter stars. Taking 0·0 as the absolute magnitude of an average giant white star, the radius of our local system is found to be 2500 parsecs.

THE DYNAMICAL EQUILIBRIUM OF THE STELLAR SYSTEM.—Prof. A. S. Eddington contributes an important paper to the centenary number of *Astron. Nach.*, in which he makes a further advance in the solution of this problem; his first approximation, in which he took the shape of the system as spherical, was published in Monthly Notices, R.A.S., vol. 75. He passes on in the present paper to consider the much more difficult problem of an oblate system, and succeeds in finding one exact solution as follows: A rotating system that has settled down to a steady state may be presumed to be oblate. If we divide it into two identically equal systems, and reverse the direction of rotation of one of them, we shall have a non-spherical system in equilibrium, with no rotation as a whole, but with preferential motion in a transverse direction. The solution is worked out in detail for a homogeneous spheroid, which is shown to be strictly analogous to Maclaurin's hydrodynamical spheroid. It is inferred that non-homogeneous solutions exist. In conclusion, he points out that it is quite likely that the stellar system has not yet attained dynamical equilibrium, and may be collapsing somewhat rapidly towards a steadier condition. He has hopes that the advance of knowledge of stellar masses and velocities may enable the matter to be decided by using the principle that in dynamical equilibrium the total kinetic energy is half the exhaustion of potential energy.

OBSERVATIONS WITH THE COOKSON FLOATING TELESCOPE.—This instrument, which floats in a circular tank containing mercury, was designed by the late Mr. Bryan Cookson, and given after his death to the Syndics of the Cambridge University Observatory. It has been on loan at the Royal Observatory, Greenwich, since 1911, and a memoir just published discusses the observations of the first seven years. The primary object was the redetermination of the aberration constant, while the variation of latitude is a useful by-product. Pairs of stars are selected at about the same distance from the zenith and on opposite sides, and with right ascension difference of a few minutes of time; their magnitudes vary from 5 to 6·5. The trails of brighter or fainter stars are too broad or too faint for accurate measurement. Three solutions are given for the aberration constant and for the corresponding value of the solar parallax as follows:—

Ab. const.	Parallax	
20·442″	8·815	General solution.
20·455	8·810	Discordant plates rejected.
20·460	8·808	Correction for wind direction applied.

The probable errors of aberration and parallax are 0·013″ and 0·006″ respectively. The third solution resulted from an examination of the "night errors," which led to the conclusion that they depend largely on the direction of the wind. This, combined with the dissymmetry of the ground-level to the north and south of the instrument, is presumed to produce inclination of the atmospheric strata and anomalous refraction. It will be seen that the values for the parallax do not differ too widely from Mr. Hinks's value 8·806″. The period of observation is, however, not considered quite long enough to eliminate accidental error, and the observations are being continued for another seven years.

Progress in Palæontology.

H. YABE and S. Endô (Sci. Rep. Tôhoku Uni., Sendai, Geology, vol. 5, p. 93, 1921) have re-examined the specimen believed to be a Sigillarian stem, found in Suruga Province by K. Fujii in 1915. While they suspend judgment on this specimen, they are now able to record the discovery of stems of Calamites by S. Makabe in the province of Iwami. These are the first Palæozoic land-plants recorded from insular Japan. The Carboniferous beds with which they are associated are marine, and it seems unlikely that any considerable flora will be unearthed comparable to that known from the adjacent continent.

Zoning by Foraminifera received a new impetus from the division of the well-known genus Orbitoides into a restricted group and two other genera. When cut horizontally, the equatorial layer in these discoidal forms shows chambers of lozenge shape in Orbitoides, which is Cretaceous, of rectangular shape in Orthophragmina (Eocene), and of hexagonal shape in Lepidocyclina (Upper Eocene and Oligocene). C. W. Cooke and J. A. Cushman ("Orbitoid Foraminifera from Georgia and Florida," U.S. Geol. Surv., Prof. Paper 108–G) in 1917 described forms of Orthophragmina, usually stellate, from the Ocala Limestone of the south-eastern States, and thus assigned to this horizon an Eocene age. In Prof. Paper 125–D, 1920, J. A. Cushman investigates and illustrates by bold photographs "The American Species of Orthophragmina and Lepidocyclina." Many of these forms were described by the author in 1919 in Pub. 291 of the Carnegie Institution; but thirteen others are new, and the whole group will be of interest for comparison with those of India and other countries. From Japan, for instance, we receive H. Yabe's "Notes on two Foraminiferal Limestones from Borneo" (Sci. Rep. Tôhoku Univ., Geology, vol. 5, p. 100), with illustrations of flexed forms of Orthophragmina side by side with Assilina and Nummulites. Yabe also describes (p. 97) four species, representing three genera, of arenaceous foraminifera that came to light on cleaning Japanese nummulites to which they were adherent. This opens a suggestive line of research.

T. W. Vaughan (U.S. Geol. Surv., Prof. Paper 98–T) uses the reef-coral fauna of Carrizo Creek, California, to show that in Pliocene times a renewed connection took place between the Atlantic and the Gulf of California across Central America. Owing to the formation of a land area from north to south, Pacific elements disappeared from the Atlantic fauna after the Upper Oligocene epoch. At Carrizo Creek, however, Atlantic forms occur in Pliocene strata, similar to those of Florida and the West Indies, and there is, curiously enough, no admixture of Pacific forms. The belt of Cainozoic limestone in Porto Rico, with its curious "pepino" structure, has been mentioned recently in NATURE (vol. 105, p. 147). The New York Academy of Sciences now continues its scientific survey by issuing Bela Hubbard's report on "Tertiary Mollusca from the Lares District"; these are mostly of Middle and Upper Oligocene age. Among other works on mollusca we may note the additions to our knowledge of fossil Unionidæ in the Indian region made by E. Vredenburg and B. Prashad (Rec. Geol. Surv. India, vol. 51, pp. 368 and 371, 1921), since members of this family have hitherto been known only from the late Cretaceous intertrappean beds in the Peninsula and from the Lower Miocene of Baluchistan. Prashad's *Lamellidens Vredenburgi* is from the intertrappean beds of Narbada; it is the oldest known representative of this genus, which is one of the dominant members of the Unionidæ in the modern Indian fauna, and it is thus probably very near the point at which Lamellidens branched from Unio. In another recent part of the Records (vol. 51, pp. 66–152) E. Vredenburg reviews the whole family of the Cypræidæ, the earliest known members of which are the strongly differentiated genera Gisortia and Eocypræa in the Albian stage. He emphasises d'Orbigny's separation of Ovula, a delicate shell that probably existed before Eocene times, and would (p. 82) ally it to the Strombidæ rather than the Cypræidæ.

The Yorkshire Geological Society (Proc., 1919–20, p. 359) publishes the last work of the late Lt.-Col. Wheetton Hind, who was equally devoted to Carboniferous fossils and to his artillery in the field. Goniatites are here described from a zone lower than any previously known in the British Carboniferous series, the Upper C Beds of Vaughan, and this record from Kniveton, Derbyshire, is worth making, though the species are not new. S. S. Buckman's fine work on "Type Ammonites" has been recently referred to in NATURE (vol. 106, p 103), and has now reached its twenty-eighth part. New names seem abundant and inevitable, but there is something magniloquent in the passage of *Ammonites giganteus* into *Titanites titan*. J. W. Tutcher's beautiful illustrations will console and guide curators who have the courage to start afresh on their collections.

P. E. Raymond's "Contribution to the Description of the Fauna of the Trenton Group" (Canada Geol. Surv., Museum Bull. 31, 1921) contains a number of observations on cystidea. The photograph of four discoidal specimens of Isorophus in their natural position on the sea-floor is a pleasing picture of Ordovician times. The species figured, which is common at Ottawa, has hitherto been regarded as *Agelacrinites Billingsi*. Prof. Raymond has undertaken a far more ambitious piece of work in his monograph on "The Appendages, Anatomy, and Relationships of Trilobites" (Mem. Connecticut Acad. Arts and Sciences, vol. 7, 1920, Newhaven, Conn., 6 dollars). This is dedicated to the memory of C. E. Beecher, whose numerous photographs of specimens showing appendages are here for the first time reproduced. Dr. Elvira Wood has rendered great assistance in her reconstructions of trilobites in their habit as they lived. We wish that Miss Woodward's sombre drawings of marine life in Palæozoic times could have found a place in the bibliography; Prof. Raymond, however, attributes to most trilobites a power of swimming that lifts them well above the level of H. M. Bernard's "browsing annelids" (Quart. Journ. Geol. Soc., vol. 51, p. 358). When we regard Burmeister's "View of an *Asaphus cornigerus* from below" (Ray Soc. ed., pl. 6, Fig. 8), with its attempt at the restoration of parts that were believed to be irrecoverable, we can imagine how this pioneer would have hailed the delicate drawings of Ceraurus (pl. 11), Triarthrus, and Neolenus in the present memoir. Burmeister emphasised the relationship of the trilobites to the phyllopod Branchipus; Bernard found their nearest ally in Apus; Raymond (p. 127) now observes that "the thoracic limbs of Apus must be looked upon as highly specialised instead of primitive," since the ancestral Branchipoda of Middle Cambrian times had simple biramous appendages. He believes (p. 146) that the higher crustacea are all derived from the trilobita,

and that the ancestor of the latter was a pelagic arthropod with few segments, the crawling habit being a modification. The carapace may have been developed in consequence of this habit, and may at first have been unsegmented. The numerous appendages arose at this stage, but their presence broke up the dorsal test into corresponding segments as swimming and crawling activity developed. The elongate worm-like character of some trilobites with many segments, such as Robergia of the Middle Ordovician, is thus held to be a secondary character (pp. 138 and 151). Walcott's Marrella (p. 115) from the Middle Cambrian is here handsomely restored, and so far no biramous appendages are known in connection with its head-shield. It is regarded (p. 143) as an already specialised link between the trilobites and the higher crustacea. Raymond's thoughtful and stimulating work revives many memorable discussions, and it reverses accepted opinions for reasons that are simply stated. The details of Beecher's observations receive their fullest exposition and illustration from a pupil who has used them aptly as a basis for independent thought.

In the palæontology of early vertebrates even a footprint may count for much. Our minds are still obsessed by the mysterious impressions in Devonian strata to which Marsh assigned the name Thinopus. R. S. Lull's traces of *Dromopus* (?) *Woodworthi*, n. sp. (*Amer. Journ. Sci.*, vol. 200, p. 234, 1920), from an Upper Carboniferous shale in Massachusetts, are regarded by the author as possibly reptilian. It is pointed out that Williston's *Isodectes Copei* would have made an impression much like that already known as *Dromopus agilis*, Marsh; both these are Carboniferous, and Isodectes is already held to be a reptile. Chelonians are prominent in two recent papers. Eduardo H. Pacheco (*Iberica*, vol. 15, p. 328, 1921) gives photographs of the wonderful assemblage of gigantic turtles in an Upper Miocene flood-deposit in the Otero de Palencia, a hill rising from the tableland of Old Castile. Similar forms are known from the Miocene continental deposits of the neighbourhood, but the examples at Palencia, 1½ metres in diameter, seem to have been brought together by the sudden overflow of a river that entombed them in its sand. They resemble the living, but distinctly smaller, tortoises of the Galápagos Islands; the islands, by the by, received their name from these quaint inhabitants. Nine specimens have been unearthed, and those in a fair state of preservation are destined for the museum in Madrid. C. W. Gilmore (U.S. Geol. Surv., Prof. Paper 98-Q) describes well-preserved carapaces of turtles in the Ojo Alamo (late Cretaceous) sandstone of New Mexico. Associated with them are handsome skulls of the dinosaurian Kritosaurus, a genus described by B. Brown in 1910. The author in a second paper (Prof. Paper 103) introduces a newly found dinosaur, Brachyceratops, from beds of similar age in north-western Montana. The modelled restoration (pl. 1) is founded on a skull and on the scattered remains of five individuals (compare pl. 4). It is represented with two stumpy horns, supraorbital and nasal, and a conspicuous bony frill extending backwards, but by no means so deterrent as that of Triceratops. The specimens are small, and may be immature. The length of the skull is 565 mm. A few other reptilian remains are noticed in the paper.

The Marsh collection at Yale continues to supply material for a number of researches on Cainozoic vertebrata. R. S. Lull describes Oligocene camels (*Amer. Journ. Sci.*, vol. 201, p. 392, 1921); E. L. Troxell (*ibid.*, vol. 200, pp. 243, 361, and 431, 1920) examines the giant pigs styled entelodonts, and introduces the new genera Megachœrus and Chærodon. The skull of the former has a length of 760 mm. and singularly large plate-like dependent malar processes (p. 433). The canines of Chærodon are remarkably recurved (p. 442). Both these genera are Oligocene. The same author (*ibid.*, vol. 202, p. 41, 1921) deals with the origins of the rhinoceros. He points out that in fossil forms the females are hornless, while the males have horns, and that the term Aceratherium, used for all hornless rhinoceroses, ceases to be of value. Other characters than those of the nasal bones indicate, however, that there is a group to which the name may be restricted in the Old World. Troxell lays much stress on Cænopus, of the American Middle and Upper Oligocene, as the ancestor of all later forms, including the modern genera of rhinoceroses. In connection with this point, the observations of H. Matsumoto are of interest (Sci. Rep. Tôhoku Univ., Sendai, Geology, vol. 5, p. 75, 1921), since the author suggests the migration of the Miocene rhinoceros Teleoceras (pp. 81 and 88) from Palæarctic Asia to North America, together with other mammalian forms. He describes a new species from Japan, which he regards as more archetypal than the American Teleoceras. Returning to the Marsh collection, M. R. Thorpe proposes some new terms to facilitate the use of skull-measurements in his review of the Oligocene felidæ (*Amer. Journ. Sci.*, vol. 200, p. 207, 1920).

G. A. J. C.

The Tea Industry.

"THE Production of Tea in the Empire and its Relation to the Tea Trade of the World" forms the subject of a comprehensive paper contributed by Mr. A. S. Judge to the Bulletin of the Imperial Institute (vol. 18, No. 4). The paper gives an interesting survey of the spread of tea-drinking in different countries, with particulars of the condition of the industry in all tea-producing areas.

Fifty years ago China and Japan produced practically all the tea consumed in the world; twenty years later, in 1890, India and Ceylon were seriously challenging China's monopoly, until at the present time they produce more than two-thirds of all the tea which enters the world's commerce, while their most serious competitor is Java, in which country tea can be produced more cheaply than in either India or Ceylon. At the beginning of 1919 prices in London for all grades of tea were good and stocks in the United Kingdom were not excessive, but apparently trade had been disorganised by the war and by Government control, and since none of the danger-signals pointing to over-production were raised, the plantations in the British and Dutch East Indies produced tea to their full capacity. The Russian market, which had been taking 100,000,000 lb. of plantation tea yearly, was lost, and large stocks began to accumulate, until in the middle of 1920 the actual situation was realised and there followed a break in prices for all the lower grades, which have since been selling below the economic value. There is no question regarding the soundness and ultimate prosperity of the Indian and Ceylon tea industries, but the immediate outlook for many estates is very critical, particularly those estates which produce mainly medium-grade teas.

It is to the common interests of both the producer and the consumer that the tea industry should be

placed on a sound basis. The most serious obstacle to the return of healthy trade conditions is the great accumulation of stocks of common teas. Since the Russian demand has ceased there appears to be little hope, at least in the immediate future, of reducing the volume of these stocks, but unless this is effected or the sales of tea are regulated there can be no recovery in prices for a long time.

In connection with this may be considered an article by Mr. J. W. McKay in the April issue of *Tropical Life*. The author considers that although at this period of depression in the tea industry the prospects are certainly dull, yet now is the time to make plans for the improvement of old tea estates in order to be ready for the better times ahead. With regard to many long-established estates it may be advisable to abandon certain areas as being too poor to be profitable, but the greater proportion will probably pay for better methods of cultivation. Most of the older tea estates show signs of reduced fertility, due partly to the rapid decay of organic matter which takes place in all tropical soils, but more particularly to the unrestricted "wash" which has been allowed to go on for years. Such action means that the fine soil particles are irrevocably lost, and when the surface-soil is once gone it cannot be easily replaced. When plenty of fresh land was available this deteriorated land was simply abandoned, and such will probably be the fate of considerable areas of old tea land. There is much to be said for this treatment, since it means that labour can be concentrated on the better areas which remain. Several methods for improvement are discussed: the construction of terraces and the planting of such shrubs as *Tephrosia candida* to prevent loss of surface-soil, trenching, limited collar pruning accompanied by manuring, the provision of adequate shade (since tea was originally a jungle plant), and, finally, an intelligent use of artificial fertilisers.

University and Educational Intelligence.

MANCHESTER.—On Saturday, November 26, a memorial tablet to the late H. G. J. Moseley was unveiled by Mrs. Sollas, the mother of this distinguished young man of science, in the presence of a considerable number of friends and colleagues. Prof. W. L. Bragg said that the request for funds for the purpose of commemorating Moseley's life and work in Manchester had met with a most generous response, both in this country and abroad, and in addition to setting up the tablet it had been found possible to institute a Moseley memorial prize in physics. Sir Ernest Rutherford spoke at some length of the brilliant achievements of Moseley in his all too short research career, and lamented the loss which science suffered when Moseley was killed at Suvla Bay. Prof. Rutherford recalled the affection which he and other co-workers cherished for Moseley. In conclusion he offered the memorial tablet to the University on behalf of the subscribers, and it was accepted by the Vice-Chancellor, Sir Henry A. Miers. The tablet is a circular one of bronze, and is fixed to the wall of the staircase outside one of the physical laboratories, and bears the words: "In Memory of Henry Gwyn Jeffreys Moseley, M.A. (Oxon.), Lecturer in Physics and John Harling Research Fellow in the University of Manchester, Lieutenant Royal Engineers, killed in action on Gallipoli, August 10, 1915, aged 28 years. Discoverer of the Law defining the Order and Number of the Elements."

AN address on "The Natural and Artificial Disintegration of Elements" is to be delivered to the Royal College of Science Chemical Society by Sir Ernest Rutherford to-day, December 8, at 4.30 p.m. Among other meetings of this society arranged for the current session are lectures by Prof. Norman Collie on "The Rare Gases," and by Sir William Bragg on "X-Ray Work," which will be delivered on January 26 and February 23 respectively.

THE annual meetings of the Geographical Association will be held at Birkbeck College on January 5–6. On the opening day the presidential address will be delivered by Lord Robert Cecil, and the following papers will be read: "London and Westminster Contrasted: A Study of the Geographical Factors which have Influenced their Situation and Development," by Mrs. Ormsby; "Problems of the Pacific," by Sir Halford Mackinder, and "The Anthropological Institute and the Services it can render to Geographical Students," by Mr. E. N. Fallaize. Mr. R. L. Thompson will open a discussion on geography and history in schools The papers to be presented on the second day of the meeting are as follows: "The Co-operation of Historians and Geographers," by Dr. H. J. Fleure (at King's College); "Some Climate Problems of Modern Palestine," by Miss L. Winchester, and "The Hejaz," by Dr. D. G. Hogarth.

THE Lord Mayor of London has issued an appeal for English books for the University of Latvia, one of the new Baltic States, where it has been decided that English shall be the first foreign language to be taught both in the University and in the schools. English and English ideals will, therefore, henceforth take a very important place in the education of this new State. The teaching of English is, however, sadly hindered by the dearth of good books in our language, and the purchase of these at the present time by the Letts is impossible owing to the very adverse rate of exchange. This condition of things might easily be remedied, for there must be many hundreds of books—standard works in our language, disused school books, scientific, engineering, and other professional works—for which their owners no longer have any use. It is for books of these types, which might be used in teaching English, that the appeal is made. Gifts of books should be forwarded to Sir Alfred T. Davies, c/o the Consul-General for Latvia, 329 High Holborn, London, W.C.1.

ON November 29 H.E. the Swedish Minister and other members of the Anglo-Swedish Society listened to an interesting account by Mr. G. R. Carline of the visit which he made to Sweden this year, as a scholar of the society, to study the open-air museums of that country. Again in 1922 the society has decided to award two travelling scholarships of 50*l*. each to qualified British students of either sex residing in the British Isles to enable them to visit Sweden and there carry out a definite course of study. The following conditions are prescribed:—That the candidates should utilise their journey for definite investigation work; that they should present a report of their activities in Sweden; and that they should take up the scholarship within six months of nomination. Applications must reach the secretary of the society at 10 Staple Inn, London, W.C.1, not later than February 1, 1922, and should be accompanied by letters of recommendation from a university professor or from the head of a recognised institution. The

decisions of the committee will be announced not later than March 15, 1922.

A LIST of one hundred popular books in science compiled by a committee of the Washington Academy of Science is published in the Journal of the Academy of September 19 last. The list is strictly tentative, and the Academy invites criticisms and suggestions. The first test for the kind of book desired for the list was: Would the average reader who uses a public library, after beginning to read the book in question, read it through to the end and come back to the librarian for another on the same subject? The second test was that it should have been written by an author who understood his subject thoroughly, and that it should not be so old as to be obsolete in its facts and speculations. The committee points out that though librarians may be able to discover which books are interesting, they have no good way of finding out which of these interesting books are trustworthy and which are not merely unorthodox, but misleading or misinforming. It is here that a scientific body such as the Washington Academy is able to help. Ordinary text-books and books written in text-book style are excluded from the list. After each title the committee makes a short statement explaining why the book is recommended and how far more than a rudimentary knowledge of the subject is needed for its full appreciation. Although in a list compiled for American libraries one would expect to find that a majority of the books recommended were by American authors, we observe with satisfaction that no less than 43 out of the 100 books are by British authors. Among these we naturally find Charles Darwin, Francis Galton, and Robert Ball, but we must refrain from giving the complete list.

ATTENTION is being directed once more in the public Press to the scheme for raising University College, Reading, to the status of an independent university. So long ago as 1906 Lord Haldane predicted that within a few years the college would develop into a university, and in 1911 a committee, appointed in 1909 to consider the question, reported in favour of such a project, and at the same time, for its furtherance, an endowment fund of 200,000*l.* was presented to the college by the late Mr. G. W. Palmer, the late Lady Wantage, and Mr. Alfred Palmer, the present chairman of the council. Preparations for applying for a charter as an independent university, interrupted by the war, were finally completed in June, 1920. The arguments relied on by the supporters of the scheme were summarised in an article which appeared in these columns eighteen months ago. Briefly, they are as follows:—Large existing endowments (265,000*l.*); heavy and increasing enrolment of students (more than 1600 in 1920–21, including 549 full-time students); residential accommodation more ample than in any modern English university; adequate equipment for teaching and, in several departments, for research; a reputation which draws students not only from distant parts of the United Kingdom, but from the Continent and the British Dominions overseas. The Privy Council considered the application sympathetically, but decided against the immediate grant of a charter; they suggested the renewal of the application, however, when the number of full-time students should have further increased and the income should have been raised to about 80,000*l.* The council has resolved to apply itself with ardour to the task of fulfilling these conditions. An offer by Messrs. Huntley and Palmer of a donation of 10,000*l.* to the college for the purposes of agricultural research has just been announced, one of the conditions being that the college obtains a university charter.

Calendar of Scientific Pioneers.

December 8, 1864. George Boole died.—While professor of mathematics at Queen's College, Cork, Boole published his "Differential Equations" and his "Calculus of Finite Differences," in both of which he employed symbolic methods. His "Laws of Thought" (1854) is one of the first attempts at "the employment of symbolic language and notation in a wide generalisation of logical processes."

December 8, 1894. Pafnutiy Lvovich Chebichev died.—One of the most eminent of Russian mathematicians, Chebichev held the chair of mathematics in the University of St. Petersburg from 1859 to 1880, and wrote memoirs on the theory of numbers, the theory of probabilities, quadratic forms, and other subjects.

December 9, 1891. Sir Andrew Crombie Ramsay died.—The successor in 1871 of Murchison as director of the Geological Survey of Great Britain, Ramsay also held the chair of geology at the Royal School of Mines. Accounted the best field geologist in the country, he also contributed to physical and dynamical geology.

December 9, 1908. Oliver Walcott Gibbs died.—Graduating in medicine at New York, Gibbs studied under some of the great chemists of Europe, and afterwards held professorships at New York and Harvard. He did original work in inorganic chemistry and was among the first in the United States to introduce research as a means of instruction.

December 10, 1889. Lorenzo Respighi died.—Like his countrymen Secchi and Tacchini, Respighi was devoted to spectroscopy, and added much to the knowledge of solar physics. From 1865 he held a chair of astronomy at Rome.

December 12, 1777. Albrecht von Haller died.—Scholar, poet, botanist, anatomist, and physiologist, Haller held a chair at Göttingen, where he organised a botanical garden and an anatomical theatre, and helped to found the Academy of Sciences.

December 13, 1565. Konrad von Gesner died.—One of the "Encyclopædic" naturalists, Gesner was called by Cuvier "the German Pliny." He was professor of Greek at Lausanne and professor of natural history at Zurich. His "Historia Animalium" (1551–58), designed to contain all then known of every animal, has been referred to as the starting-point of modern zoology.

December 13, 1891. Jean Servais Stas died.—After working for a time in conjunction with Dumas at Paris, Stas settled in Brussels and devoted himself mainly to the precise determination of atomic weights, for which in 1885 he was awarded the Davy medal of the Royal Society.

December 14, 1557. Niccolo Tartaglia died.—The contemporary and rival of Cardan, Tartaglia was a self-taught mathematical genius who commenced lecturing at Verona, and in 1535 was appointed to a chair at Venice. His "Nuova Scienza" appeared two years later. Cardan published Tartaglia's solution of a cubic equation without authority.

December 14, 1873. Jean Louis Rudolphe Agassiz died.—Known first for his epoch-making work on fossil plants and his glacial studies, Agassiz in 1846 left Switzerland for the United States, where he afterwards occupied a leading position in the world of science. He held a chair at Harvard, founded the Museum of Comparative Zoology, and contributed much to the natural history of both South and North America. He was among those who did not accept the doctrine of evolution. E. C. S.

Societies and Academies.

LONDON.

Royal Society, November 24.—Prof. C. S. Sherrington, president, in the chair.—K. **Sassa**: (1) Observations on reflex responses to the rhythmical stimulation in the frog. In the study of the relation between the frequency and intensity of stimulation and the resulting reflex reactions, there is an optimal intensity when the rate of stimulation is rapid. There is also an optimal rate for any given intensity. The reflex contraction evoked at this rate is often nearly as powerful as the direct one obtained by similar stimulation. (2) The effects of constant galvanic currents upon the mammalian nerve-muscle and reflex preparations. The main points of inquiry have been: (*a*) The relation between reflex excitation and inhibition of the decerebrate tonus of the vasto-crureus; (*b*) whether the "excitation formula" (Pflüger's law) holds good in mammalian afferent nerves; and (*c*) whether there is continuous excitation during the passage of the current through an afferent nerve.—E. **Ponder**: The hæmolytic action of sodium glycocholate. The hæmolytic power of sodium glycocholate is greatly increased by the addition of small amounts of histamine or histidine. Erythrocytes can be rendered immune to the hæmolysis produced by such mixtures by the previous addition of histamine to the suspension. The hæmolysis is probably due to changes of surface tension.—Dorothy J. **Lloyd** and C. **Mayes**: The titration curve of gelatine. Hydrochloric acid combines with gelatine in solutions the acid concentrations of which are less than 0·04 normal, according to the law of mass action. K_b for gelatine is $4{\cdot}8 \times 10^{-12}$ if 839 be taken as the reacting weight of gelatine. Combination probably occurs at the free $-NH_2$ groups present in some of the amino-acids of the gelatine. In dilute sodium hydroxide (less than 0·01 normal), gelatine combines with the base at a slower rate than that calculated from data used in acid experiments. The number of positions of attachment for bases is probably not the same as the number of positions for acids.—D. H. **de Souza** and J. A. **Hewitt**: Idio-ventricular periodicity. A perfusion experiment on the excised heart of the frog was described, in which periodic grouping occurred as an independent ventricular phenomenon.

Zoological Society, November 22.—Prof. E. W. MacBride, vice-president, in the chair.—A. S. **Le Souëf**: The early life-history of Ornithorhynchus.—A. **Smith Woodward**: A human skull and other remains from Broken Hill, North Rhodesia, upon which the species *Homo rhodesiensis* was founded. In comparing the Rhodesian skull with a Neanderthal skull from La Chapelle, the author stated that the former may prove to be the next grade after Neanderthal in the ascending series.—C. F. **Sonntag**: Contributions to the visceral anatomy and myology of the Marsupialia.—H. **Matsumoto**: Megalohyrax (Andrews) and Titanohyrax, g.n.. A revision of the genera of Hyracoids from the Fayûm, Egypt.

Geological Society, November 23.—Mr. R. D. Oldham, president, in the chair.—K. W. **Earle**: The Lower Carboniferous rocks of West Cumberland. The zonal sequence of the Carboniferous rocks of Westmorland and Lancashire is traced into Cumberland. The lowest beds resting against the Lake District massif belong to the *Nematophyllum-minus* sub-zone. The only outlier of Carboniferous Limestone within the massif itself consists, at the base, of beds of that zone. The Lake District massif was probably an island in earliest Carboniferous times, and complete submergence did not take place until D_1 times. The irregular distribution and thickness, the constituent materials, and the high angle of dip of the Polygenetic Conglomerate beneath the gently dipping limestones, confirm earlier conclusions as to its Devonian age. The Millstone Grit is variable in thickness, composition, and stratigraphical horizon in various parts of the area, and there are valuable iron-ore deposits in the limestone series near Whitehaven.—W. G. St. John **Shannon**: A composite sill at Newton Abbot (Devon). The intrusive nature of the sill, which occurs at the summit of Knowle's Hill, is shown by the spotting of the overlying slates. Considerable differentiation has taken place, and the sequence is that of a plutonic phase from basic to more acid, in the order: picrite, dolerite, bostonite; mugearite occurs as a modification of the dolerite. The somewhat sharp junctions and the xenoliths of picrite in dolerite suggest that differentiation took place in the magmatic reservoir. Intrusions occurred before the cooling of the earlier rocks, since the newer show no selvage. Intrusion probably took place during the later stages of folding, but before final cessation of the movement.

DUBLIN.

Royal Dublin Society, November 22.—Dr. F. E. Hackett in the chair.—W. R. G. **Atkins**: (1) Some factors affecting the hydrogen-ion concentration of the soil and its relation to plant distribution. The reaction of the soil is considered in relation to the limiting hydrogen-ion concentrations of solutions of various carbonates, and to these as altered by other salts. The availability of phosphates and iron salts varies with the soil *p*H values. Heating increases the *p*H value of alkaline soils. There is a relation between the typical reactions of the soil and the rocks, limestone, sandstone, slate, plutonic, etc., giving rise to it. Plant distribution is limited in a very definite manner by the *p*H value of the soil, as shown by study of a hundred species. Natural fresh-water has been found to vary from *p*H6·4 to 8·3, or when insolated with algæ to *p*H9·7. (2) The hydrogen-ion concentration of plant-cells. An acidity as great as *p*H1·4 has been observed in sap; plant-cells are rarely alkaline. Microchemical tests show that the xylem is more acid than the pith and medullary rays. The transpiration stream in Colocasia is almost neutral, but the glandular secretions of *Drosera rotundifolia* are acid, *p*H5. The acidity of a tissue is usually near, but below, the optimum for the action of its characteristic enzyme. For such tests diethyl-red is a useful indicator. (3) Note on the occurrence of the finger-and-toe disease of turnips in relation to the hydrogen-ion concentration of the soil. Soil giving a badly infected crop was found to contain 0·17 per cent. of calcium oxide and to be as acid as *p*H6·6; the adjoining field, which gave a good undiseased crop, had 0·40 per cent. of calcium oxide, and was at, or slightly more than, *p*H6·7

EDINBURGH.

Royal Society, November 7.—Prof. Bower, president, in the chair.—C. V. **Raman**: The phenomenon of the radiant spectrum observed by Sir David Brewster. Brewster observed early last century that when a bright image of the sun was observed through a prism of small dispersion there was seen beyond the violet end of the spectrum a bright radiant source. This is explained in terms of the diffraction of the light through the diffracting medium of the eye.—Henry **Briggs**: Prehensility, a factor of gaseous adsorption. Experiments were described on the adsorption of different kinds of charcoal and silica at very low

pressures and at the temperature of liquid air, the practical aim being to determine the vacuum-producing power of such adsorbents, especially in regard to the efficiency of metallic Dewar vacuum vessels. The paper also discussed the advantage of evacuating by means of charcoal contained, not in a single vessel, but in a series of vessels, which are to be utilised in succession.—Henry **Briggs**: The Military Physical Test Station, Edinburgh. The purpose of the station was to test men drawn from the Army units in Scotland who proved to be refractory material in the hands of the drill sergeant, and to discriminate between the malingerer and the person who was actually of low physical capacity. The method of testing was determined after a long series of experiments. Instructive cases were cited and graphical records shown as to the physical performance of different men.—E. T. **Whittaker**: Tubes of electromagnetic force. A mathematical investigation on four-dimensional relativity lines, which by generalising the conception of tubes of force co-ordinated in an interesting way the electrostatic and the magnetic tubes created by Faraday and developed by Maxwell, Sir J. J. Thomson, and others.

PARIS.

Academy of Sciences, November 21.—M. Georges Lemoine in the chair.—MM. **Constantin** and **Dufour**: Researches on the biology of the Monotropa. At a spot in the forest of Fontainebleau *Monotropa Hypopithys* has been found growing abundantly, and this material has been examined for a fungus, since *Calluna vulgaris*, and other species of Ericaceæ have been shown to carry a fungus. A species was found, apparently new, to which the provisional name of *Monotropomyces nigrescens* has been given, and details are given of the media upon which this can be grown.—A. **Calmette**, L. **Nègre**, and A. **Boquet**: Tuberculous antibodies. It is concluded from the experiments described that the antibodies—"Sensibilisatrices antituberculeuses"—even when employed in large doses, have no bactericidal power, and are incapable of producing the disintegration, either *in vitro* or *in vivo*, of the tubercle bacillus. They do not neutralise tuberculin, and exert no favourable influence on the course of tubercular infection. Hence it is useless to place the slightest hope in the therapeutic effects of the antibodies contained in the so-called antituberculous sera.—M. Marcel Brillouin was elected a member of the section of general physics in succession to the late M. G. Lippmann.—T. **Varopoulos**: Some properties of increasing functions.—G. **Julia**: Integral or meromorphic functions.—M. **Riabouchinski**: The resistance of viscous fluids.—H. **Grouiller** and J. **Ellsworth**: New elements of light variation of the variable star VV Orionis. A study of the changes in brightness of variable stars in the cases due to eclipses has shown that there are many difficulties in the interpretation of the observations, due probably to imperfection of the data. The star VV Orionis of this type has been chosen for detailed examination, and 300 observations taken between November 3, 1916, and March 11, 1921, by J. Ellsworth are now discussed. The value for the period given by Hertzsprung is appreciably modified (+0·00842 day).—F. **Michaud**: The surface tension of electrified liquids. It is shown that theoretically, from the principle of energy, the surface tension should be independent of the state of electrification of the surface. This conclusion has been verified experimentally, a method being chosen which eliminates the effects of electrostatic repulsion.—A. **Sellerio**: The thermal analogue of the axial galvanomagnetic effect.—E. **Berger** and G. **Crut**: The equilibrium in the reduction of nickel chloride by hydrogen. The reaction indicated by the equation

$$NiCl_2+H_2 \rightleftharpoons Ni+2HCl$$

is reversible, and the equilibrium concentrations are the same, starting either from left or right. The constant K in the Nernst equation has been determined, K=5·93.—L. **Guillet**: The thermal treatment of certain complex aluminium alloys. In order to extend and explain the results obtained by the thermal treatment of duralmin, alloys of aluminium and copper, aluminium and silicon, aluminium, silicon, and copper, aluminium, silicon, and magnesium, and alloys containing all four constituents, have been studied, and the results of the micrographic examination are given. In all cases the simultaneous presence of silicon, magnesium, and copper is indispensable to obtain the interesting results given by tempering high resistance aluminium alloys.—E. **Grandmougin**: Octobromindigo.—C. **Dufraisse** and P. **Gérald**: The supposed true dibenzoylmethane of Wislicenus: some new experiments. In an earlier communication it has been shown that the Wislicenus compound is probably not $(C_6H_5\cdot CO)_2=CH_2$. From the results now given it is concluded that the supposed dibenzoylmethane of Wislicenus is $C_6H_5\cdot CO\cdot CH=C(OC_2H_5)\cdot C_6H_5$, and the mechanism of its production is explained.—G. **Denizot**: The upper peneplain of the Paris basin and the primordial levellings of the periphery.—O. **Mengel**: The Canigou and the Maladetta, poles of the primitive axis of the Pyrenees.—S. **Stefanescu**: The practical and phytogenetic importance of the T_4 of the molars of mastodons and elephants.—F. **Kerforne** and Y. **Milon**: Observations on two recent shocks of the Armorican massif.—J. **Lacoste**: Contribution to weather prediction, especially storms, by observations with pilot balloons.—G. **Guilbert**: The formation of rain and the origin of cirrus clouds.—Ph. **Schereschewski** and Ph. **Wehrlé**: The movement of the nuclei of pressure variations.—Mlle. Y. B. **de Black** and P. **Marty**: The constitution of the Cantalian volcanic massif.—St. **Jonesco**: The transformation of the chromogens of some plants into a red pigment by oxidation.—H. **Ricome**: The problem of geotropism.—R. **Morquer** and J. **Dufrenoy**: Contribution to the study of the formation of a jelly from the lignified membrane of the Spanish chestnut.—E. **Chemin**: The corrosive action of plant roots on marble. The etching action of plant roots on polished marble has been variously attributed to the action of acetic, propionic, butyric, malic, and hydrochloric acids secreted by the root hairs. The author's experiments lead him to the conclusion that the roots of plants excrete no sensible amounts of any acid other than carbonic acid, and it is shown that this excretion is sufficient to account for the corrosion of the marble.—M. **Marage**: Protection against sound vibrations.—J. **Pellegrin**: The reproduction in an aquarium of a Brazilian fish, *Acara tetramerus*.—L. **Boutan**: The origin of the pearl sac and the mode of formation of pearls.—E. **Fauré-Fremiet**: Constitution of the egg of *Sabellaria alveolata*.—Mlle. H. **Goldsmith**: The phototropic reactions of some marine animals.—E. **Le Danois**: The biology of the white tunny-fish.—Ed. and Et. **Sergent**, L. **Parrot**, A. **Donatien**, and M. **Béguet**: The transmission of the Biskra boil by *Phlebotomus papatasi*.

MELBOURNE.

Royal Society of Victoria, July 14.—D. K. **Picken**: The Euclidean geometry of angle. The author introduces a fundamental geometrical figure, the complete angle, intermediate between straight line and (complete) triangle, with the notations (l_1, l_2), (AB, CD),

or simply AOB, equivalent to (OA, OB). The complete angle congruence, expressed as $(l_1, l_2) \equiv (l'_1, l'_2)$, or $AOB \equiv A'O'B'$, is shown to be the characteristic angle relation of elementary geometry; its use gives greater simplicity and generality to geometrical theory.

Books Received.

Seventh Scientific Report on the Investigations of the Imperial Cancer Research Fund. Pp. viii+91+22 plates. (London: Taylor and Francis.) 15*s*.

Report of the Canadian Arctic Expedition, 1913–1918. Vol. 5: Botany. Part A: Vascular Plants. By J. M. Macoun and T. Holm. Pp. 25+13 plates. (Ottawa: F. A. Acland.)

Berichte des Ohara Instituts für Landwirtschaftliche Forschungen in Kuraschiki, Provinz Okayama, Japan. By M. Kondō, Nōgaku-Kakuschi. Band 1, Heft 5. Pp. 519–628+plates 8–11. (Kuraschiki: Ohara Schönōkai.) 2.80 yen.

Modern Methods of Welding as Applied to Workshop Practice. By J. H. Davies. Pp. xviii+263. (London: Constable and Co., Ltd.) 21*s*.

Laboratory Exercises in Applied Chemistry for Students in Technical Schools and Universities. By Dr. W. Moldenhauer. Authorised translation by Dr. L. Bradshaw. Pp. xii+236. (London: Constable and Co., Ltd.) 12*s*. 6*d*.

A History of the Association Psychology. By Prof. H. C. Warren. Pp. x+328. (London: Constable and Co., Ltd.) 16*s*.

Hydraulics of Pipe Lines. By Prof. W. F. Durand. (Glasgow Text-books of Civil Engineering.) Pp. xvi+271. (London: Constable and Co., Ltd.) 18*s*.

Fuel and Lubricating Oils for Diesel Engines. By W. Schenker. Pp. xii+114. (London: Constable and Co., Ltd.) 10*s*.

Principles and Practice of Business. By G. Mairet. (Life and Work Series.) Pp. xii+301. (London: Macmillan and Co., Ltd.) 5*s*

A First Book of Applied Electricity. By S. R. Roget. (First Books of Science Series.) Pp. viii+142. (London: Macmillan and Co., Ltd.) 2*s*. 6*d*.

The Autonomic Nervous System. By Prof. J. N. Langley. Part 1. Pp. viii+80. (Cambridge: W. Heffer and Sons, Ltd.) 5*s*. net.

A Concise Guide to the Town and University of Cambridge: In an Introduction and Four Walks. Originally written by Dr. J. W. Clark. Seventh edition, entirely revised. Pp. xx+199+map. (Cambridge: Bowes and Bowes.) 1*s*. 6*d*. net.

Oils, Fats, and Fuels. By Thomas Hull. Pp. viii+143. (London: Blackie and Son, Ltd.) 3*s*. 6*d*. net.

Agricultural Progress in Western India. By G. Keatinge. Pp. xii+253. (London: Longmans, Green and Co.) 6*s*. net.

Les Sciences et le Pluralisme. By J.-H. Rosny, aîné. (Nouvelle Collection scientifique.) Pp. iv+210. (Paris: F. Alcan.) 8 francs net.

Oil Shales. By Dr. H. B. Cronshaw. (Imperial Institute Monographs on Mineral Resources, with Special Reference to the British Empire.) Pp. x+80. (London: J. Murray.) 5*s*. net.

The Prevention of Malaria in the Federated Malay States: A Record of Twenty Years' Progress. By Dr. M. Watson and others. Second edition, revised and enlarged. Pp. xxviii+381. (London: J. Murray.) 36*s*. net.

Diary of Societies.

THURSDAY, DECEMBER 8.

ROYAL SOCIETY, at 4.30.—Lord Rayleigh: A Study of the Glow of Phosphorus, Periodic Luminosity, and Action of Inhibiting Substances (with experimental Demonstration).—Lord Rayleigh: The Aurora Line in the Spectrum of the Night Sky.—E. F. Armstrong and T. P. Hilditch: A Study of Catalytic Actions at Solid Surfaces. VII., The Influence of Pressure on the Rate of Hydrogenation of Liquids in Presence of Nickel.—W. D. Womersley: The Energy in Air, Steam, and Carbon Dioxide from 100° C. to 2000° C.—Lt.-Col. J. W. Gifford: Atmospheric Pressure and Refractive Indices, with a Corresponding Table of Indices of Optical Glass.—H. P. Waran: A New Form of Interferometer.—H. Harle: The Viscosities of the Hydrogen Halides.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Charles Ballance: A Glimpse into the History of the Surgery of the Brain (Thomas Vicary Lecture).

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), at 5.30.—Dr. A. G. S. Mahomed: The Relation of Atmospheric Electrical Variations to the Incidence of Epileptic Fits.—Discussion on the Organisation of the Section.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—L. C. Martin: The Physical Meaning of Spherical Aberration.—Dr. F. Lloyd Hopwood: An Auto-stroboscope and an Incandescent Colour Top.—Lt.-Col. Gifford: Achromatic One Radius Doublet Eyepieces.

CHEMICAL SOCIETY (at Institution of Mechanical Engineers), at 8.—Prof. J. W. Gregory: The Genesis of Ores.

INSTITUTE OF METALS (London Section) (at 85 The Minories), at 8.—S. A. E. Wells: Casting in Metal Moulds.

ROYAL SOCIETY OF MEDICINE (Neurology Section) (at Hospital for Paralysis, Maida Vale), at 8.—Clinical Meeting.

CAMERA CLUB, at 8.15.—Capt. H. Lambart: The Intricacies of the Silent Drama and its Making.

HARVEIAN SOCIETY (at Medical Society of London), at 8.30.—Sir John Charlton Briscoe, Bart., Sir Sidney Russell Wells, Dr. G. H. Hunt, and Sir William Willcox: Discussion: Is the Anginal Syndrome only of Cardiac Origin?

SOCIETY OF ANTIQUARIES, at 8.30.

FRIDAY, DECEMBER 9

INSTITUTION OF WATER ENGINEERS (at Geological Society), at 10 a.m.—L. H. Lewis: The Manchester Water Works.—J. Don: Adsorption in Sand Filters.—C. F. Newton: Indicating and Recording Instruments.—P. B. Crosthwaite: The Louth Flood of 1920.—D. H. Thompson: Hydrological Conditions in the Chalk at Compton, West Sussex.—Discussion: The Final Report of the Water Power Resources Committee.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botanical Lecture Theatre, Imperial College of Science and Technology), at 2.30.—Prof J. H. Priestley and others: Discussion: The Resistance of the Normal and Injured Plant Surface to the Entry of Pathogenic Organisms.

JAPAN SOCIETY, at 5.—W. L. Schwartz: The Potters and Pottery of Satsuma.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—G. A. Sutherland and L. Clark: The Average Range of β-rays in Different Metals.—Prof. E. Wilson: The Sensitivity of Ballistic Galvanometers.—Prof. R. Ll. Jones: The Determination of the Damping Decrement of a Tuning Fork.—Dr. E. A. Owen: The Estimation of the Radium Content of Radio-active Luminous Compounds.

ROYAL ASTRONOMICAL SOCIETY, at 5.—W. M. H. Greaves: Certain Periodic Orbits in the restricted Problem of Three Bodies.—W. M. H. Greaves: Long-period Inequalities in the Movements of Asteroids of which the Mean Motions are nearly half that of Mars.—J. van der Bilt: Observations of Comets made with the 10-inch refractor of the University Observatory, Utrecht, Holland.—A. A. Nijland: Observations of Comet 1921*a* (Reid) made with the 10-inch refractor of the University Observatory, Utrecht, Holland.—Rev. T. G. R. Phillips: The Third Satellite of Jupiter.—Royal Observatory Greenwich: Mean Areas and Heliographic Latitudes of Sunspots in the year 1917.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—Continuation of Discussion on Ball and Roller Bearings: Some Recent Types and Criticisms.

JUNIOR INSTITUTION OF ENGINEERS (at Royal United Service Institution), at 7.30.—C. H. Wordingham: Presidential address.

ROYAL SOCIETY OF MEDICINE (Electro-therapeutics Section), at 8.30.—Dr. Carelli: Demonstration of a Method of Radioscopic Examination with the Help of Gas Injections.—Dr. Riddell: Demonstration of a Simple Apparatus for Making Serial Radiographs of Pyloric Region in the Horizontal and Upright Positions.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—Clinical Evening.

SATURDAY, DECEMBER 10.

INSTITUTION OF WATER ENGINEERS (at Geological Society), at 10 a.m.—L. H. Lewis: The Manchester Water Works.—J. Don: Adsorption in Sand Filters.—C. F. Newton: Indicating and Recording Instruments.—P. B. Crosthwaite: The Louth Flood of 1920.—D. H. Thompson: Hydrological Conditions in the Chalk at Compton, West Sussex.—Discussion: The Final Report of the Water Power Resources Committee.

GILBERT WHITE FELLOWSHIP (at Lowther Lodge, Kensington Gore, S.W.7), at 2.30.

MONDAY, DECEMBER 12.

ROYAL BOTANIC SOCIETY OF LONDON, at 3.—Prof. A. W Bickerton: Gardening (3): Artistic Gardening.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge, Kensington Gore, S.W.7), at 5.—Capt. J. B. L. Noel: Photographic Equipment and Methods for Travellers.
ROYAL SOCIETY OF ARTS, at 8.—A. M. Hind: Processes of Engraving and Etching (Cantor Lecture) (3).
SURVEYORS' INSTITUTION, at 8.—A. A. Hudson: The Relation of Soil to Plant Growth, and in Particular when Influenced by the Presence or Absence of Lime.

TUESDAY, DECEMBER 13.

ROYAL HORTICULTURAL SOCIETY, at 1.
EUGENICS EDUCATION SOCIETY (at Royal Society), at 5.—Prof. E. W. MacBride: The Inheritance of Acquired Characters and its Bearing on Eugenic Theory and Practice.
INSTITUTION OF CIVIL ENGINEERS, at 6.—E. Latham: Deep-water Quays: General Considerations of Design.—F. E. Wentworth-Shields: The Stability of Deep-water Quay-walls.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Technical Meeting.
QUEKETT MICROSCOPICAL CLUB, at 7.30.—T. E. Wallis: Microscopy as an aid to Analysis.
FARADAY SOCIETY (at Chemical Society), at 7.45.—Annual General Meeting.
CHEMICAL INDUSTRY CLUB AND LONDON SECTION OF SOCIETY OF CHEMICAL INDUSTRY (at Institution of Mechanical Engineers), at 8.—Cinematograph Films on the Winning and Working of Sulphur.—The Manufacture of Steel: Crucible, Open Hearth, Electric, and Bessemer Processes.—The Metallurgy of Zinc.
ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 8.—W. J. Sandeman and others: Discussion: Progress in Gas Lighting in Relation to Illuminating Engineering.
FARADAY SOCIETY (at Chemical Society), at 8.15.—Prof. A. O. Rankine: The Structure of Gaseous Molecules.
ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—N. W. Thomas: The Week in West Africa.

WEDNESDAY, DECEMBER 14.

SOCIETY OF GLASS TECHNOLOGY (in Chemistry Lecture Theatre, University College), at 2.45.—V. Stott: Note on Pipettes.—A. J. Dalladay and F. Twyman: Measuring small variations of Refractive Index throughout Meltings of Optical Glass.—F. Twyman: The Annealing of Glassware, and Annealing without Pyrometers
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—H. J. Waring: The Operative Treatment of Malignant Disease: Its Possibilities and Limitations (Bradshaw Lecture).
ROYAL METEOROLOGICAL SOCIETY, at 5.—Discussion on Visibility, opened by F. J. W. Whipple: A general survey of the subject: Wing Commander M. G. Christie: from the Air Pilot's point of view; Captain Sir David Wilson-Barker: from the Seaman's point of view; Dr. J. S. Owens: London Fogs.
INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 8.—H. F. L. Orcutt: Motor-car Gear Boxes.
ROYAL SOCIETY OF ARTS, at 8.—Sir Walter B. Townley: Trade with the Netherlands East Indies.

THURSDAY, DECEMBER 15.

LINNEAN SOCIETY OF LONDON, at 5
NEWCOMEN SOCIETY (at King's College, Strand, W.C.2), at 5.—Annual General Meeting.—At 5.15.—R. C. S. Walters: Greek and Roman Engineering Instruments.
LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—J. H. Jeans: The New Dynamics of the Quantum Theory (Lecture). The following papers will be taken as read:—W. P. Milne: The Relations Between Apolarity and Clebsch's Mapping of the Cubic Surface in a Plane.—Miss G. D. Sadd: Certain Types of Plane Unicursal Curves.—H. M. Shaffer: The General Theory of Notational Relativity.—Pundit Oudh Upadhyaya: (1) Note on Gauss's Quadratic Identity; (2) A General Formula in Cubic Forms.—J. R. Wilton: Gibbs's Phenomenon in Fourier's Series and Integrals.
INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—Discussion on Paper by H. F. Collins: The Igneous Rocks of the Province of Huelva and the Genesis of the Pyritic Orebodies.—A. V. Reis: Underground Working of Wide Pyritic Orebodies.
ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Capt. F. M. Green: Development of the Fighting Aeroplane.
CHILD STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Miss von Wyss: Vital Elements in Art Teaching.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—L. H. A. Carr: Induction-type Synchronous Motors.
CONCRETE INSTITUTE, at 7.30.—E. F. Sargeant: (*a*) The Preparation of Concrete Aggregates; (*b*) Moving Forms.
CHEMICAL SOCIETY, at 8.—G. T. Morgan and J. D. Main Smith: Researches on Residual Affinity and Co-ordination. Part VII., Cobaltic Lakes of the Alizarin Series.

FRIDAY, DECEMBER 16.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—G. Mitchell: Conveying and Elevating Machinery.—R. E. Knight: Discharge of Grain Cargoes in the Port of London by Pneumatic Elevators.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 8.—L. Richmond: Address.

SATURDAY, DECEMBER 17.

PHYSIOLOGICAL SOCIETY (at London Hospital).

PUBLIC LECTURES.

(A number in brackets indicates the number of a lecture in a series.)

THURSDAY, DECEMBER 8.

HOSPITAL FOR SICK CHILDREN (Gt. Ormond Street, W.C.1), at 4.—H. A. T. Fairbank: Coxa Vara.
UNIVERSITY COLLEGE, at 5.—Prof. J. E. G. De Montmorency: Feudal Vestiges in America and Elsewhere (6).
IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—W. Bateson: Recent Advances in Genetics (6).
KING'S COLLEGE, at 5.30.—H. W. Fitz-Simons: Bridge Construction (5).
ST. JOHN'S HOSPITAL (Leicester Square, W.C.2), at 6.—Dr. W. Griffith: Eczema (Chesterfield Lecture).
BARNES HALL (1 Wimpole Street, W.1), at 8.—Dr. C. Singer: The History of the Doctrine of Infection (Chadwick Lecture).

FRIDAY, DECEMBER 9.

UNIVERSITY COLLEGE, at 8.—Prof. G. Dawes Hicks: Our Knowledge of the Real World (6).

SATURDAY, DECEMBER 10

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 10.30 a.m.—Prof. W. W. Watts: Geology as a Basis for Geography (Lectures for Teachers).

MONDAY, DECEMBER 12.

ROYAL COLLEGE OF SURGEONS, at 4.—F. W. Twort: Recent Researches on the Biology of Bacteria (Brown Lecture) (1).
KING'S COLLEGE, at 5.30.—H. Moore: Liquid Fuels (5)

TUESDAY, DECEMBER 13.

ROYAL COLLEGE OF SURGEONS, at 4.—F. W. Twort: Recent Researches on the Biology of Bacteria (Brown Lecture) (2).
KING'S COLLEGE, at 5.30.—Prof. H. Wildon Carr: The Modern Scientific Revolution and its Meaning for Philosophy (10).—Dr. W. Brown: Psychology and Psychotherapy (9).

WEDNESDAY, DECEMBER 14.

SCHOOL OF ORIENTAL STUDIES, at 5.—J. W. Gill: The Arab Intrusion into Bornu.

THURSDAY, DECEMBER 15.

ROYAL COLLEGE OF SURGEONS, at 4.—F. W. Twort: Recent Researches on the Biology of Bacteria (Brown Lecture) (3).
UNIVERSITY COLLEGE, at 5.—Prof. J. E. G. De Montmorency: Religion and Feudalism (7).

CONTENTS.

	PAGE
Imperial Water Power	457
The Denomination "Chemist"	458
Echinoderm Larvæ and their Bearing on Classification. By Dr. F. A. Bather, F.R.S.	459
Electrotechnical Theory. By A. R.	461
British Scientific and Technical Books. By F. W. Clifford	462
The Statecraft of Ancient Greece. By H. W. C.	463
Our Bookshelf	463
Letters to the Editor:—	
Propagation of Waves in an Isotropic Solid. (*With Diagrams.*)—A. Mallock, F.R.S.	465
The Action of Sunlight: A Case for Inquiry.—Dr. C. W. Saleeby	466
Relativity and Materialism.—Prof. H. Wildon Carr; Canon Edmund McClure	467
The Radiant Spectrum. (*Illustrated.*)—Dr. H. Hartridge	467
Microscope Illumination and Fatigue.—J. E. Barnard	468
Hybridity and the Evolution of Species.—Prof. J. Brontë Gatenby	469
A Simple Micro-barograph. (*Illustrated.*)—A. Wechsler	469
Scientific Workers in Russia.—Prof. V. Korenchevsky	469
The Maintenance of Scientific Research. By Prof. C. S. Sherrington, Pres.R.S.	470
The Rayleigh Memorial: The Unveiling in Westminster Abbey. (*Illustrated*)	471
International Physico-chemical Symbols. By Prof. Alex. Findlay	474
Obituary:—	
Dr. J. A. Allen	475
W. A. Baillie-Grohman	475
Notes	476
Our Astronomical Column:—	
The Effective Wave-Length of the Light of Galactic Stars	480
The Dynamical Equilibrium of the Stellar System	480
Observations with the Cookson Floating Telescope	480
Progress in Palæontology. By G. A. J. C.	481
The Tea Industry	482
University and Educational Intelligence	483
Calendar of Scientific Pioneers	484
Societies and Academies	485
Books Received	487
Diary of Societies	487

THURSDAY, DECEMBER 15, 1921.

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The Research Department.

THE sixth Report of the Committee for Scientific and Industrial Research,[1] which was recently issued, deals with a number of matters of scientific importance. It seems but a short time since the establishment of the Department, described in the pages of NATURE for May 20 and July 29, 1915, or the deputation to Lord Crewe, at which the promise of the million fund for the endowment of industrial research was made, and Sir J. J. Thomson pointed out the importance of fostering research in pure science, which, as he said, might lead to a revolution of methods, while from industrial research we could only hope for a reformation of details in method or procedure.

The Report before us naturally falls into three sections: (1) The report to his Majesty in Council of the Committee of Council; (2) the report to the Committee of Council of their Advisory Council; (3) details of the work of the various research boards and committees established under the scheme, including a list of publications both of the Department and of individuals in receipt of grants.

The Committee of Council, like the Board of Trade, has a somewhat shadowy existence. The only names which appear in the Report are those of Mr. A. J. Balfour, the Lord President, and Sir Frank Heath, the secretary. A list of the original Committee is given in the White Papers issued by Mr. Arthur Henderson when President of the Board of Education in 1915 (NATURE, vol. 95, p. 604). Since that date the direct connection between the Committee and the Board of Education has been severed.

The Report to his Majesty is naturally a somewhat formal document; it gives details of the expenditure in various directions—*e.g.* there are now twenty-six research associations, and the total expenditure in grants to these was 74,557*l.* 1*s.* 2*d.*; the balance of the million fund unexpended at March 31 was 903,205*l.* 8*s.* 10*d.*, but it is stated that "of this sum a large percentage has already been earmarked for prospective commitments to associations already formed." In view of the financial stringency, it was arranged last year that a considerable portion of the income from this fund should be appropriated in aid of the vote of the Department. The amount so utilised was about 38,000*l.* This is an arrangement which, in present circumstances, may be necessary, but is not desirable.

Turning now to (2), the Report of the Advisory Council, it is of interest to repeat from the White Paper already quoted the primary functions of the Council. They are to advise the Committee of Council on:

(i) Proposals for instituting specific researches.
(ii) Proposals for establishing or developing special institutions or departments of existing institutions for the scientific study of problems affecting particular industries and trades.
(iii) The establishment and award of research studentships and fellowships.

To these must be added another important matter, outlined in last year's Report, which has taken effect during the year under review, viz. the establishment of co-ordinating boards to organise work which is of common interest to the fighting Services of the Crown. In addition to co-ordinating the work in the various Departments, it is the duty of the boards "to arrange for researches for which inadequate provision is made."

Four boards have been appointed to deal respectively with chemistry research, engineering research, physics research, and radio research. They comprise representatives of the Services and independent men of science, and an interesting account is given of their work, "which, up to the present, has been that of preparation rather than

[1] Report of the Committee of the Privy Council for Scientific and Industrial Research for the Year 1920-21.

of achievement." The task before the boards is not an easy one; in most cases they can only give advice, though where a research is financed by a board they have more power, and success depends on the friendly co-operation established between the board and those in charge of the work at the various departmental laboratories. The officers of the boards are fully aware of this, and the relations which have been established are thoroughly satisfactory.

Turning now to the research associations established under clause (ii) of the original scheme as special institutions "for the scientific study of problems affecting industries and trades," there are, as has already been stated, twenty-six of these. The Report gives an account of the work of some, and of these perhaps the most important is the British Cotton Industry Research Association shortly to find a permanent home at Didsbury, near Manchester. Its programme of research directs attention to two possible lines of advance:

"(1) To attack problems directly by methods based on past experience without seeking to investigate the fundamental nature of the process.

"(2) To try to understand the chemical and physical changes produced during manufacture, and so to establish gradually a broad roadway along which future advances may be made."

The Cotton Association proposes to seek the advance of the industry mainly by the second line. Its directors have realised the necessity of fundamental research, a matter to which we return below, but this recognition is apparently not shared by all the associations, for a warning given in the last Report against the short-sighted policy of confining research associations to the search for results of immediate commercial value is repeated.

The actual results achieved by the twenty-six associations are somewhat meagre, but three years, the time which has elapsed since the first was founded, is too short a period in which to expect much of fundamental value. The Council point out that it is premature to look to the research associations yet for convincing proof of the effectiveness of co-operative industrial research, and with this view there will probably be general agreement. Still, there are difficulties to be surmounted. Among them one discussed at one of the conferences of associations held at the Department is of great importance: To what extent may an association undertake for its members work of a kind hitherto carried out by the professional analyst or testing engineer? The view was urged by some that consulting work was of definite value to the progress of research, while another association felt that research should only be carried to the initial stage of practical application, the individual firms being left to work out the method of applying the new knowledge to their own particular problems. On this point one may ask the question, Can they do it? Much depends, no doubt, on the problem; in any industry there are probably a number of large firms with their own scientific staffs who have ample opportunity for working out the details of a new process, and it is likely that this can be done to greater advantage in the works than in the research association laboratory. But this does not apply to the small firms to be found in large numbers in any industry, which, if the association is to benefit the trade, must be brought in and given the means of utilising the results. Experience shows that a process has to be carried a long way before it can be usefully applied by such firms, and while this is not the same as undertaking consulting work, it must be carried out at the laboratory of the association. It will be found, no doubt, in the long run, that no rigid rule can be laid down. Each association must work out for itself the problem of combining pure research with industrial practice.

This naturally leads to a consideration of the steps the Council is taking to encourage pure research dealt with under (i) and (iii) of the original scheme, though, did space permit, much more might be written about the work of the other committees and boards of the Department. Encouragement is given (*a*) by financing specific researches carried out by competent men, and (*b*) by research studentships. The applications for grants are divided into those (1) for students in training, (2) for research workers or research assistants, (3) for laboratory or clerical assistants, and (4) for equipment.

The applications numbered 333 in all, of which 245 were granted, 36 refused, and 52 referred elsewhere. Of the 245 granted, 132 went to students in training and 70 to research workers or assistants; of the 132 students in training, 95 are engaged in chemical work, but comparatively few of these, we may surmise, are doing fundamental research; they have not yet reached the stage at which this is possible, being still "in training"; some few may in time become research workers and add to the

stock of fundamental knowledge. Further details are given in appendix 2, while in appendix 3 we have a list of aided researches; scarcely one of these deals with work in pure science; they include glass technology, the corrosion of condenser tubes, the flow of steam through nozzles, and other similar investigations of an industrial character. An exception should be made in the case of the work on tides now in active progress at Liverpool University, but here, too, the results have a direct industrial bearing. On the other hand, appendix 4—publications by individuals in receipt of grants—does contain a number of papers of the greatest importance to pure science—*e.g.* Dr. F. W. Aston on "Mass Spectra and Atomic Weights"; Sir Ernest Rutherford, "The Nuclear Constitution of Atoms" and "The Mass of the Long-range Particles from Thorium-C," with many others of less striking merits—while an interesting list is given on p. 73 showing the wide range of science covered by the papers. It appears that during the year under review a sum of 40,850*l.* was spent on these grants, while provision is made for the expenditure of 50,000*l.* during the current year, but by no means all of this was for the advancement of pure research, and the criticism may be made that, compared with the amounts available for industry, the sum devoted to pure research is but small.

Yet it is difficult to see how it could be greatly different. The men capable of original research in pure science are limited in number. We have long known that *Poeta nascitur non fit* and poetry and original discovery have much in common. Imagination of a high order, combined with skilled training and a real grasp of essential principles, the love of knowledge for its own sake, the readiness to pursue it whithersoever it may lead, and the opportunity to do this when the exceptional man is found, are all required. The opportunity implies freedom from too much pure routine and financial worries. The best course the Advisory Council can adopt is to see that all those who have shown the incipient signs of this ability should have the opportunity and the freedom. The Council realises this in theory; it was pointed out in the Report for last year that "no conditions are attached to the grants made to workers whose sole aim is the extension of knowledge either as to the line of their work or as to the use to be made of their results." If a discovery is to be made use of commercially, application must be made to the Department.

This is as it should be, but it is almost equally important that the same principle should apply to work done for the research associations or in the various laboratories controlled or aided by the Department. It is impossible to evaluate pure research on principles which apply to a works, or even to a works laboratory engaged mainly on routine testing and the examination of products. There is a real danger lest the time of men thoroughly competent to carry out fundamental investigations of high value should be absorbed in serving tables, in compiling details of the hours and minutes spent on this or that job, or in writing minutes in reply to official inquiries. It is difficult, no doubt, for a Government Department to avoid this; there are Treasury rules to be followed, but the error comes in the attempt to apply these rules to conditions for which they were never intended.

It should be noted, however, as the Council itself points out, that the funds which it administers in grants to workers mainly at the universities are only a small portion of the sum contributed by the State through other agencies to university education and research. It is not the business of the Council to pay professors and teachers. It can make grants only for individual pieces of work, and this function we may fairly hope it will discharge when once convinced of the importance of the work and the capacity of the worker, with a broad faith and without too narrow an inspection of details.

The Report covers much ground, and much more could be written about it, but space forbids. One matter, however, mentioned at the end, must be noticed. The results of research become known through the publications of the scientific societies, and many societies are in a difficult position financially, and find it impossible to make both ends meet. The matter has been considered by the Conjoint Board of Scientific Societies, but it moves slowly; still, it is intended that a statement of the case should be presented in the near future to the Treasury. The Council had referred to the matter in the Report for last year, and it now states:

"We have learned with satisfaction that action has already been taken by the scientific societies on the lines suggested in our Report of last year, and should they apply for, and receive, Government aid through the Treasury under a well-thought-out scheme, we should welcome the removal of a serious obstacle to the progress of science in this country."

Gas Warfare.

Chemical Warfare. By Brig.-Gen. Amos A. Fries and Major C. J. West. Pp. xi+445. (New York and London: McGraw-Hill Book Co., Inc., 1921.)

IT is earnestly to be hoped that every British man of science will take the opportunity of studying this account of chemical warfare prepared by Brig.-Gen. Fries and Major West, of the United States Army. He will then be able to make up his mind, knowing the facts, as to the possibility of eliminating gas warfare by edict or mutual consent while war itself remains a possibility as before. Having answered this implied question, he must needs ask himself what is his own particular responsibility in the matter.

The need for propounding these questions is undoubted. Recent protests by certain eminent chemists, directed against the organisation of research for chemical warfare purposes, make it clear that considerable divergence of opinion exists as to the *rôle* which should be adopted by men of science in maintaining international peace. On one hand is the desire to withdraw all semblance of support from the perpetuation of what is regarded as a peculiarly inhumane method of waging war. On the other is the belief that, whatever we do, chemical warfare has come to stay; that peace and our national security will best be safeguarded by placing ourselves at least on an equality with our neighbours as regards the new warfare; and that, since, if we wish peace, we must be ready to fight for it, the man of science must shoulder his burden and prepare to become the military arbiter of the future. It is the old political battle of armaments transferred to the scientific arena.

In these circumstances, therefore, we are exceedingly fortunate in having the facts of chemical warfare placed before us so completely and clearly from an outside source. In Fries and West's book there is little of special pleading beyond that of military exigency. It supplies a full—indeed, a most astonishingly full—account of gas warfare in general, and, in particular, the part played by the United States in building up what was eventually the largest chemical warfare service of any of the belligerent nations.

It is highly significant, too, of the present position in America that the veil is withdrawn for the first time from many of the most carefully guarded chemical warfare secrets of the past. For example, a whole chapter is devoted to the thermal production of particulate clouds. Side by side with these frank disclosures are the following statements—the first, in the foreword, by Major-Gen. W. S. Sibert, General Fries's distinguished predecessor as Chief of the Chemical Warfare Service in America; the other in the body of the book:—

"There is no field in which the future possibilities are greater than in chemical warfare, and no field in which neglect to keep abreast of the times in research and training would be more disastrous."

"Poison gas in the World War proved to be one of the most powerful of all weapons of war. For that reason alone it will never be abandoned. It cannot be stopped by agreement. . . ."

From the considered inclusion of such opinions in a book redolent with disclosure only one conclusion can be drawn.

The United States Chemical Warfare Service was built up almost wholly on the foundations of British practice and experience. To this fact and to the subsequent intimate relations between the two services Fries and West pay generous tribute. As to the magnitude of the American organisation, its success in every branch and its clear-sighted vision, facts are allowed to speak for themselves. Owing to the cessation of hostilities the full extent of the American chemists' great effort was probably never generally realised in England, and only partially, perhaps, even in the inner circles of the War Office and the Ministry of Munitions. Yet it was unquestionably one of the greatest achievements of the war. Starting literally from nothing, the Americans within nine months elaborated a service in which research, manufacture, training, and field organisation were brought to the highest pitch of efficiency. In Washington the research department under Burrell mustered a chemical *personnel* of 1200, which included men of international reputation such as Wilder Bancroft, Hulett, W. K. Lewis, and Tolman. It is small wonder, therefore, that some very fine work was accomplished.

It is, however, by a consideration of Edgewood Arsenal that the full extent of the American chemical warfare effort can best be gauged. Built on an isolated tract of country in Maryland, this poison-gas factory attained a magnitude which is simply staggering. By October, 1918, it employed 10,247 men, and was successfully making chloropicrin, phosgene, mustard gas, bromobenzylcyanide, and other accessory chemicals, and was in a position to turn out 100 tons of liquefied chlorine a day. As a feat of chemical engineering alone it must be almost unique. As an indication of what can be accomplished without recourse to

existing plant it gives one food for considerable thought.

The success of Edgewood Arsenal and the gas mask factories was due in no small measure to the inauguration of a development division intermediate between the Research Department and the manufacturing plants. The difficulties attending large-scale production were overcome in the single-unit plants of the development section, and the results obtained immediately transferred to Edgewood and the subsidiary factories spread up and down the country. Only in this way was it possible to maintain throughput at its maximum and avoid the time- and labour-consuming hindrances notoriously attendant on the alteration of existing plant or the installation of new. It is a procedure heartily to be commended to many of our own industrial concerns, where much good research is wasted by inability of the works to cope with difficulties which could well be overcome by experimentation on full-sized units.

Of course, even in America, the enormous chemical warfare organisation did not come into being without attendant inefficiencies. General Fries points out the difficulties he encountered in having his cabled demands from the Expeditionary Force attended to (did he but know it, he was no worse off in this way than the British, who were fighting almost at their own door). This was due to a lack of co-ordination between the numerous extensive divisions of the service, each of which had grown up separately. Eventually a Chief of the Chemical Warfare Service was appointed, but in the interim the various separate activities were held together only by the personal efforts of William H. Walker, of the Massachusetts Institute of Technology. General Fries and Major West are not sufficiently appreciative of Walker's efforts during this disquieting period. In service to his country Walker accomplished in this unofficial co-ordination something even greater than his subsequent organisation and control of Edgewood Arsenal. Without him General Fries and the American Expeditionary Force would have had to remain dependent for supplies on Britain for many months longer than they did.

The book is full of information of a technical nature previously denied to the average man of science, and even without its clarity and illuminating illustrations would hold the reader enthralled from start to finish. It is a fine compilation and a great tribute to American chemists. Its publication can do nothing but good in throwing light on a subject of ever-increasing international importance. Its extensive sections, dealing with the legitimacy of gas warfare and its possibilities in the future, are highly stimulating, but must be read in conjunction with the remainder properly to be appreciated. Sufficient has been quoted above to indicate the authors' views on the subject.

No British notice of "Chemical Warfare" would be complete without reference to the now notorious "Lewisite." Whatever the British views as to the war value of chlorovinyldichloroarsine, the fact remains that the Americans rated, and still rate, it very highly indeed. It was under the strictest pledges of official secrecy that its nature and mode of preparation were imparted to the British Government. It is therefore most disquieting to find it made the subject of a communication to a scientific society without express permission being obtained from the real owners of the secret. As the communication was sanctioned by the War Office, there would appear to be two explanations required—one from the military authorities, and the other from the authors of the paper referred to. Doubtless some satisfactory explanation can be given of this "unfortunate, or otherwise" (Fries and West), occurrence, but the Official Secrets Act, our friendly relations with foreign Governments, and respected procedure regarding scientific publication, all appear to be involved. S. J. M. A.

Zoology for Medical Students.

Zoology for Medical Students. By Prof. J. Graham Kerr. Pp. x+485. (London: Macmillan and Co., Ltd., 1921.) 25*s.* net.

SUCH a title challenges attention not merely as a scientific work but as a confession of faith. It is the *credo* of one of our younger men on education at this moment when there is nothing else of such importance. A huge and undigested heap of students has been shovelled into our universities by the combined pressure of war arrears and Government subsidies (8,000,000*l.* sterling is to be spent first and last by the Treasury alone on University courses for ex-officers). These men are our inevitable masters in the decade to come. Thus vital are the principles on which Prof. Graham Kerr decides to cultivate his garden.

The professor of zoology in Scotland has a dreadful task. In ten short weeks he has to expound and classify all the innumerable combinations of living matter. In addition he has to break in to the life of a university a class of many scores—sometimes of hundreds—of last year's secondary schoolboys. The biology of the first-year medical student has to unfold its

broadest sweep when he is least capable of receiving it.

The 485 pages of reading matter and line drawings give the conspectus of the animal kingdom which it is hoped such a one may carry away. Prof. Graham Kerr in his preface sets himself three tasks: (1) To awaken and develop . . . interest in biological science. (2) To lay an adequate foundation for the superstructure of detailed knowledge of the animal body. (3) To provide a reasonably up-to-date account of the more important animal parasites, especially of the pathogenic microbes of animal origin.

The course represented by this book is preponderatingly morphological. The writer holds not only that our knowledge of the morphological features of the lower types of animal is much more advanced than our knowledge of their physiology, but also that morphological study affords a better intellectual discipline than physiological:

"The student observes structural features in the laboratory . . . and he is able to compare what he observes with what he is told or reads. When he tries to make physiological observations he finds even in the case of the simplest phenomena that behind these phenomena are at work factors, so far as he is concerned, transcendental and as far beyond his powers of criticism and comprehension as if they were the direct result of supernatural agency."

The only quarrel a student could have with the book is one which it shares with so many scientific works—that it is all so true. Few things are more devastating to the unformed mind than first contact with the vast mass of knowledge which the ant-like industry of man has piled up through the last three centuries. When the process of selection is also hidden, and the innumerable errors by which we have arrived at truth, the student is apt to think that those who have taught him so much can teach him all. His faculty of scepticism, before the brute mass of all this verity, lies down baffled, and his powers of disbelief are not reawakened for years, or for ever. The intellectual stimulus of finding a great clinician out-faced and routed at a post-mortem should not, even for the earliest years, be neglected if in any fashion it can be reproduced in zoological lecture-room or laboratory.

Therefore, although the anatomy of the higher vertebrates has been excluded from the course and the mass of detail pruned vigorously, one would plead for still further selection. By a glance at the countless mistakes of the past the investigator of the future will be encouraged. One would beg the teacher, in delivering that cataract of certainty which batters on the head of the first-year student, to remind him not only of the rightness but of the wrongness of the theories of the past, that he may pluck up heart to question those which now are current.

The book is well printed, and the line drawings are numerous and comprehensible. For examination purposes the summaries ending each chapter will prove of great value. The chapter on the Flagellata and that on the Crossopterygii are of special interest in view of the work done in these two fields by the Glasgow school.

The Study of Rocks.

Petrographic Methods and Calculations, with some Examples of Results Achieved. By Dr. A. Holmes. Pp. xix+515+4 plates. (London: Thomas Murby and Co., 1921.) 31*s.* 6*d.* net.

DR. HOLMES has produced a text-book that is likely to have a far-reaching and beneficial effect in promoting the intelligent study of rocks. Some scientific treatises are patient compilations of the common stock of theories and facts current among specialists in the subject treated. If they are at least fairly accurate and reasonably up-to-date and complete they may be of great use to the student and research worker, even if they contain little or nothing that is original or novel. Others strike out a new and independent line of their own, and deal only with certain aspects of the subject on which the author feels he has a message to deliver. These, of course, have a value of their own, though they are not available as text-books or as works of reference.

The special characteristic of the work under review is the keenness of Dr. Holmes's outlook for fresh ideas in every department of his subject. Sometimes he has evolved them for himself, sometimes he has added new developments of his own to the methods that he has met with in his unusually wide reading. He even succeeds in making the well-worn subject of specific gravity interesting, and embodies much American work that has recently been published, as well as his own experience in the investigation of building stones. In dealing with the procedure for the separation of rock minerals, he does full justice to the advances that have been made in this country in the last few years. His novel diagrams showing at a glance the refractive indices and bi-refringence of minerals are remarkably successful in giving an idea of their relations to one another and the variations that occur. The chapter on microchemistry should prove very useful, and

his advice on the examination of thin sections and the description of rocks is excellent.

We cannot agree with his adoption of the meanings attached by Prof. Shand to the terms "saturated" and "unsaturated" as applied to minerals and rocks, meaning saturated or unsaturated with silica. It is always undesirable, we think, to take a recognised word, especially one with a definite scientific meaning already attached to it, and employ it in a more restricted sense. Perhaps the most valuable chapters in the book are those on the interpretation of analyses and their representation by diagrams. We could have wished, perhaps, that greater space could have been given to the subject of the crystallisation of magmas, but this could have been effected only by an increase in the size and cost of the book.

It is to be regretted that this work was completed before the issue of the report of the Joint Committee of the Geological and Mineralogical Societies on Petrological Nomenclature, to which Dr. Holmes, who was a member of the committee, gave most valuable assistance. It is very desirable that the use of technical terms in petrology should be standardised, at any rate so far as this country is concerned.

J. W. EVANS.

Our Bookshelf.

Insect Pests of Farm, Garden and Orchard. By E. Dwight Sanderson. Second Edition. Revised and enlarged. By Prof. L. M. Peairs. Pp. vi+707. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1921.) 26*s.* net.

THE first edition of the author's "Insects Injurious to Staple Crops" was published ten years ago. The advances made during the past decade have been such that it was considered necessary to rewrite practically the whole book. In its present form it covers all the more important insects affecting the crops of the farm, garden and orchard, besides including two final chapters on household insects and the pests of domestic animals. The work aims at giving a clear idea of the life-history and habits of every species concerned and the best methods of control. There are also chapters on insecticides and spraying and dusting apparatus. It is profusely illustrated, the text-figures numbering more than 600, and with few exceptions they are of a uniform level of excellence. References in the form of footnotes guide the more inquisitive reader to many of the separate bulletins and articles on individual pests.

Notwithstanding the number of text-books on economic entomology which have appeared in America, the present work will undoubtedly occupy a high place in their ranks. Its comprehensiveness is truly remarkable and, in fact, it is difficult to quote any similar work which compresses so much well-sifted information, and so many good illustrations, within an equally convenient compass. Chap. 3, however, which deals with the structure and development of insects, is rather inadequate. In the first place it should have preceded chap. 2, which treats of beneficial insects. As it stands, the practical grower will have to read chap. 3 first if he is to understand properly the remarks in the preceding chapter. In the second place, a brief account of the principal orders of insects might have been added with advantage, even if at the expense of an additional page. But these points are comparatively trivial in what can be regarded unhesitatingly as an all-round first-rate practical book on insect pests. A. D. IMMS.

Department of Applied Statistics (Computing Section), University of London, University College: Tracts for Computers. Edited by Karl Pearson. No. 6, *Smoothing.* By E. C. Rhodes. Pp. 60+3 diagrams. (London: Cambridge University Press, 1921.) 3*s.* 9*d.* net.

THE methods of graduating or "smoothing" a series of more or less irregular data affected by errors of observation or of sampling have of recent years received a good deal of attention; the present tract is a very valuable contribution to the subject. New methods are developed, which may be described as combinations of tangential or osculatory interpolation with the least-square method of Dr. Sheppard, and these and older methods are compared, both graphically and by finding the sum of the squares of the departures from the graduated curve. The results of this test are rather surprising. The osculating methods used give distinctly worse results than the other four methods employed. By grouping the observations it is possible to estimate what order of differences is negligible; if a higher order of differences is employed, the resultant curve tends to bring out something that is not inherent in the data, with very unsatisfactory consequences to the fit obtained.

North England: An Economic Geography. By L. R. Jones. Pp. viii+256. (London: G. Routledge and Sons, Ltd., 1921.) 6*s.* net.

THERE is a distinct need for sound regional text-books of the more intensive type exemplified by this work. It deals with the coal-fields north of the Trent and the Midland Gate, and discusses the industries which have arisen upon and about them, the communications between them, and their great centres of industry and trade. The basis of discussion is very largely geological. Here there is room for broadening of both foundation and fabric. The book needs an index, and is disfigured by a number of typographical errors, but it is well illustrated with maps which, for the most part, are clear and illuminating. It makes a very useful book for secondary schools and first-year college courses.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Action of Sunlight.

REFERRING to Dr. Saleeby's letter in NATURE of December 8, p. 466, I may report that, in conjunction with the late Marshall Ward, professor of botany at Cooper's Hill, I carried out a number of experiments at Liverpool near the end of last century on the effect of light in slaughtering anthrax bacilli. Prof. Ward prepared the cultures, covered them seriatim with a quartz plate which I lent him, and then sent them to me to be exposed to a suitably arranged arc light through quartz lenses and a quartz prism, discriminating the kind of light by its effect on fluorescent paper pasted at the side. The experiments were never properly published, though they are partly described in Prof. Ward's memoir on the subject in the Phil. Trans. Unfortunately, I do not possess the B series to refer to, but Dr. Saleeby could easily find the paper, and I think it would interest him.

The general outcome, to my mind, was that the arc light was more efficient than Liverpool sunlight, but that the most effective parts of the spectrum were two strongly phosphorescing bands in the ultra-violet, not far from the visible portion, and not of such short wave-length that clean air would be opaque to them. Their wave-lengths were, in fact, about 3830 and 3250 tenth-metres.

The unpolluted atmosphere seems well adapted to screen us from the really deleterious rays of exceedingly short wave-length, while still allowing the microbe-destroying rays to come through and do their beneficent work. OLIVER LODGE.

Microscope Illumination and Fatigue.

IT is interesting to note from Mr. J. E. Barnard's letter in NATURE of December 8, p. 468, that other workers have taken up the problem of variable illumination for the microscope. But in criticising the method outlined in these columns on November 17 Mr. Barnard seems to have overlooked the important fact that a monochromatic light-filter is used, so that the question created by the shift of the dominant radiation does not arise. This shift—which in its simplest expression amounts to a reddening of the light as the temperature of the source is decreased—was fully recognised when the method of regulation was originated, and in practice is a distinct advantage, since the apparent decrease of illumination of the field, when a filter is used which passes only a small band of the spectrum, is greater than that of the light source alone, where the full spectrum is present. Hence any increase of the resistance of the circuit doubly decreases the light in the field.

The neutral wedge device described by Mr. Barnard is very ingenious, and if it can be controlled from the front of the working bench by a long actuating spindle should be of the greatest use when monochromatic light is not desired. It is not easy to put an arm round to the front of the microscope to make an adjustment without moving the eye from the eyepiece, especially when a drawing-table and other accessories are in use. The adjustable resistance can, of course, be put wherever it is most convenient to the hand, and its use in a short time becomes almost subconscious.

It would be of interest to know whether in Mr. Barnard's experience he finds that there is any increased visibility of the finer details when variable illumination is used. This is markedly the case in cytological preparations and in the examination of cotton hairs.

The use of monochromatic light, so strongly advocated by Dr. Spitta, raises several questions, and is open to criticism where double staining methods are used, though with two filters all details can usually be made out. There was a half-promise in Zeiss's 1913 catalogue of monochromat objectives. These were put on the market some years before the war, corrected for monochromatic ultra-violet light, and an admirable description of their use was given by Mr. Barnard in NATURE of November 28, 1920, but there would be a real use for monochromats for visible light of a definite short wave-length if the attention now given to apochromatism could be transferred to flatness of field. H. J. DENHAM.

Shirley Institute, Didsbury, Manchester,
December 9.

Tin Plague and Scott's Antarctic Expedition.

IT will be recalled that a chief contributing cause of the failure of Scott's party to get back to their base was the "leakage" of the fuel oil that was stored in tin cans at the depôts along the line of the return march from the Pole. The oil-cans as found were apparently intact and "without hole of any kind," and it was therefore thought by some that the oil had evaporated through the "stoppers." Scott himself, however, wrote in his last message: "We should have got through in spite of the weather but for . . . and a shortage of fuel in our depôts, for which I cannot account, and . . ."

Now it has been clearly understood since 1899, by reason, chiefly, of the continued investigations of the Dutch chemist, Prof. Ernst Cohen, and his collaborators, that ordinary tenacious white tin is no longer stable below 18° C., but may change into a modification that appears grey and pulverulent. This change, long since observed in organ-pipes and other articles in very cold climates, is referred to by Prof. Cohen as tin plague, and spreads fastest, according to him, at about −50° C. Ever since reading Scott's diary in 1913 the present writer has in his teaching been in the habit of suggesting that certain of Scott's paraffin cans contracted tin disease, thus exposing the underlying iron, in spots at least, to the danger of chemical action and so of becoming "pin-holed," with the possible aid of electrolytes present in traces from the process of refining the oil. This rather obvious suggestion has, however, not appeared in your columns, nor was it known to Prof. Cohen, who was lecturing here a few days ago, as he has lectured elsewhere in this country and in Europe, on tin plague and related matters. It was interesting to learn from Prof. Cohen that he had experience of precisely the same phenomenon in the case of canned foods stored at rather low temperatures.

ALAN W. C. MENZIES.

Princeton University, Princeton, N.J., U.S.A.,
November 25.

The Dispersal of Snails by Birds.

I WAS present at a meeting of the Malacological Society last May when Dr. Boycott read a very interesting paper, in which he showed how the small snail *Balea perversa* occurred on trees, walls, and rocks, but not on the ground. The question arose

how it got from tree to tree; and in the resulting discussion the fact was brought out that it had exceptionally tenacious slime. There appears to be no doubt that it is carried by birds, to which it may become attached at night while they are asleep. The Island of Porto Santo possesses a large number of endemic snails, and also a certain number of species, such as *Euparypha pisana* and *Cochlicella acuta* (the latter, new to the island, I found abundant locally north of the Villa Baleira), which have been introduced by man. But there is one species, *Balea perversa*, which was found by Wollaston only on the isolated summit of the highest mountain in the island, the Pico do Facho. This is far from human habitation, and it is nearly certain that the snail was not brought there by man. It is equally improbable that it is a member of the ancient fauna, remaining unchanged while all the other species have diverged in various directions. The strong probability is that it was carried by birds, which could reach the Madeiras in a short time, while the snails remained dormant attached to their legs. Mr. J. Y. Johnson many years ago cited no less than seventy species of birds which had been observed as visitors or stragglers to the Madeira Islands.

The indications are, nevertheless, that few species of snails can be carried long distances in this manner. Balea is exceptional on account of its arboreal habitat and tenacious mucus. There is, however, a small species common in Porto Santo, the *Heterostoma paupercula*, Lowe, which is also found in Madeira, all three Desertas, and in the Azores. I have observed that it adheres very tightly to rocks or other objects, and is very tenacious of life. Specimens which I collected in Porto Santo last January came to life and crawled about the other day on being moved from their positions. There can be little doubt, I believe, that this little snail has been distributed by birds.

It is even probable that certain species of Coccidæ (scale-insects) are dispersed in the same manner. On the top of the Portello Pass, Madeira, I found a strange little Coccid at roots of native grasses, and expected it would prove undescribed. Mr. E. E. Green, however, recognised it as *Ortheziola Vejdovskyi*, described from Central Europe. The larvæ of this insect could very well be carried on the feathers of birds, and, escaping at almost any point on the island, would be likely to find the necessary grass.

T. D. A. COCKERELL.
University of Colorado, Boulder, Colorado,
November 22.

The Distribution of Brightness in the Penumbra during an Eclipse of the Moon.

On the day after the eclipse of October 16, Mr. C. E. P. Brooks mentioned to me that the edge of the umbra had seemed much more sharply defined when the eclipse was nearly total than at an early stage. This observation suggested to me that it might be worth while to work out the theoretical distribution of light over the lunar disc and gain some information about the relation between umbra and penumbra. The diagrams which commonly illustrate the theory of umbra and penumbra in the text-books are shaded in such a way as to suggest that there is a sharp discontinuity in the illumination, the umbra being indicated by one uniform shading, the penumbra by another.

A little consideration shows however that the transition from bright to dark must be gradual. From the point of view of a spectator on the moon and within the umbra the sun would be entirely hidden by the earth. To a spectator in the penumbra but close to the edge of the umbra the sun would be nearly obscured, but to a spectator near the outer edge of the penumbra almost the whole of the sun would be visible. In traversing the penumbra the proportion of the sun visible would increase slowly at first, then more rapidly, the rate of increase would reach a maximum with the sun about half obscured, and finally the proportion would change but slowly when the spectator neared the outer edge of the penumbra.

The illumination received by various parts of the moon is proportional to the area of the sun as seen by the imaginary spectator, and if the local differences in reflecting power could be ignored the apparent brightness of the disc as seen from the earth would follow the same rule.

In Fig. 1 the small and large circles represent sun and earth as seen from some point on the moon, SP ($=r$) is the apparent radius of the sun, EP ($=R$) is the apparent radius of the earth, and the angles PES, PSE are denoted by β and $\pi-\alpha$ respectively. The ratio of I, the illumination of the moon at the point in question, to I_0, the illumination where there is no eclipse, is determined by the fraction of the sun that is not hidden, so that

$$\frac{I}{I_0}=\frac{1}{2\pi}\left[\left(2\alpha-\sin 2\alpha\right)-\frac{R^2}{r^2}\left(2\beta-\sin 2\beta\right)\right].$$

The angles α and β which occur in this formula are related to x, the angular distance between the

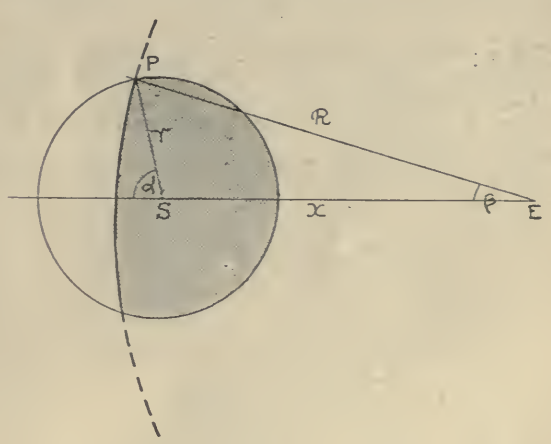

FIG. 1.

centres of sun and earth as seen from the moon, by the equations

$$\frac{R}{\sin\alpha}=\frac{r}{\sin\beta}=\frac{x}{\sin(\alpha-\beta)}.$$

For R and r the mean values 16·60 milliradians and 4·64 milliradians may be adopted. On this basis I/I_0 has been plotted as a function of x in Fig. 2.

From this figure the values of x corresponding with specified values of the ratio I/I_0 have been read off; these are shown in the following table, the unit for x being the milliradian :—

I/I_0	0	0·1	0·2	0·3	0·4	0·5	0·6	0·7	0·8	0·9	1·0
x	12·0	13·3	14·2	14·9	15·6	16·4	17·1	17·9	18·7	19·6	21·2
$(x-R+r)/2\rho$	0·00	0·14	0·24	0·33	0·41	0·49	0·57	0·66	0·74	0·85	1·03

The angle x, which was defined as the distance between the centres of sun and earth as seen from a certain point on the moon, is to a very close approximation the same as the distance of the same point of the moon from the centre of the shadow as seen from the earth.

In Fig. 3, which shows umbra and penumbra in proportion, isopleths for each multiple of 20 per cent. of full illumination have been drawn. The ratio to the lunar diameter of the distance of each isopleth from the edge of the umbra is given in the last line

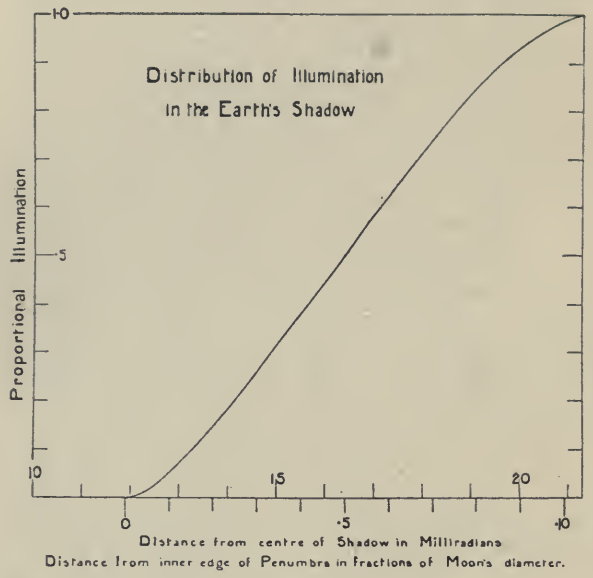

FIG. 2.

of the preceding table, the lunar diameter 2ρ being taken as 9·04 milliradians. Fig. 2 exhibits the slow variation of illumination near the inner and outer edges of the penumbra which was anticipated from general considerations.

The explanation of Mr. Brooks's observations appears to be that at the beginning of a lunar eclipse

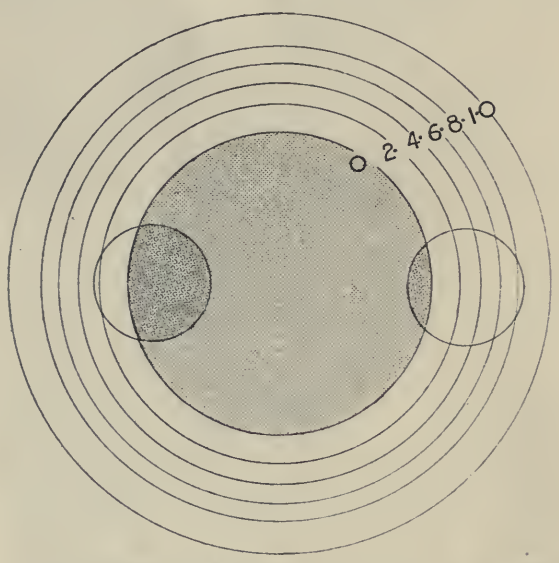

FIG. 3.—The small circles represent the moon in two positions, the shaded circle the umbra thrown by the earth, and the outermost circle the edge of the penumbra.

the range of the brightness I is from zero nearly to I_0. The dull region, say from $I=0$ to $I=\frac{1}{8}I_0$, has a width equal to 0·24 of the lunar diameter. With the eclipse approaching totality, say when the width outside the umbra is one quarter of the diameter, the maximum illumination is only $0{\cdot}21I_0$, and the dull strip, which in this case extends from $I=0$ to $I=\frac{1}{8}\times 0{\cdot}21I_0$, has a width 0·08 of a diameter. The width of the dull or fuzzy region is therefore reduced in the ratio 3 : 1. If this explanation be sound the phenomenon is physiological rather than physical.

A lunar eclipse presents another and much more difficult photometric problem: the umbra is not perfectly black, and as is well known the slight illumination it receives is due to light refracted in passing through the earth's atmosphere. It would be of interest to compare the strength of this illumination with that in the penumbra, and hence determine the fraction of sunlight which passes through our atmosphere without loss by diffraction and absorption.

Though it is hardly relevant to the subject of eclipses, it may be mentioned that a measurement of equal delicacy and greater value would be that of the brightness of the "old moon in the arms of the new," from which measurement the mean albedo of the earth could be deduced. One may even speculate on the possibility of variation in this albedo being detected, as the earth as seen from the moon is covered mostly by land or by sea or by cloud. Such knowledge would be of considerable value in the theory of the economy of the earth's thermal energy.

The new moon is observed from England after sunset when the western hemisphere mostly covered by water is facing the moon, whereas at the end of the lunar month we see the old moon in the early morning when the eastern hemisphere with the larger proportion of land is opposite to the moon. Conditions are therefore favourable for detecting the contrast in question.

F. J. W. WHIPPLE.
Meteorological Office, South Kensington,
S.W.7, November 15.

Awards to Discoverers.

IN view of the Government having enforced reductions in State funds available for research, it may be of interest to refer to the subject of awards to discoverers as means of effecting economy in, and increasing incentives to, research.

In a leading article in NATURE of March 31 last on "Inventions and Grants-in-Aid," special consideration was given to the first Report of the Royal Commission on Awards to Inventors, and also my scheme for the administration of grants for scientific discoveries and memoranda which were submitted by me to the Department of Scientific and Industrial Research. The scheme and memoranda were referred to in the article above mentioned in relation to rewards for future inventions and discoveries. In this connection I wish to direct attention to certain rulings of the Commission in respect of rewards for unpatented inventions and discoveries, particularly as the impression has been formed in certain quarters that the procedure of the Commission in respect of rewards for unpatented inventions might be made available in regard to rewards for discoveries such as those which contribute to the advancement of knowledge which it is desirable in the national interest to increase.

The discoveries for which grants may be obtained in accordance with the provisions of my scheme may be scientific or medical or surgical discoveries, and they may be described in an allocation or allocations of grants. A fund out of which grants may be allocated may be created by the State, or by means of donations and bequests, or both these sources may be made available.

I observed in my Memorandum G that "grants may be allocated to discoveries which are unremunerative,

but which have effected or contributed to the attainment of any medical or surgical purpose (specified or not as may be prescribed) of general utility or advantage which it is deemed desirable, in the national interest, to subserve."

Paragraph 29 of the Report of the Commission above referred to commences as follows:—"In a previous paragraph dealing primarily with patented inventions, it has been stated that, in the case of unpatented inventions also, the general principle has been adopted that rewards are not recommended in respect of inventions publicly proclaimed and thrown open to all the world to use." And after reference to the case of medical or surgical discoveries it is stated in this paragraph:—"Suggestions have recently been made elsewhere that a fund should be created for the pecuniary reward of investigators who have conferred great benefits on the public by such discoveries as those, for instance, which have resulted in the prevention of disease by inoculation and the like. But we have taken the view that all such matters as these lie entirely outside our province."

I may mention that in his letter appearing in the *Times* of July 13 last Sir Ronald Ross referred to a conjoint committee of the British Science Guild and the British Medical Association having written to the Prime Minister "suggesting that the powers of the Royal Commission on Awards to Inventors might be enlarged so as to include medical and sanitary discoveries and inventions." Replying in the *Times* of July 15 to this letter, Mr. Tindal-Robertson, the secretary of the Commission, in explanation of the general practice of the Commission, quoted the paragraph of the Report of the Commission which I have mentioned above.

In the case of unpatented inventions the Commission, it appears from reference to paragraph 27 of the Report, attached more importance to "priority of communication" than to "priority of discovery." And as showing that even these considerations may be outweighed by other counteracting considerations, the following statements are made in paragraph 28 of the Report:—

"It was found by the Commission that the credit of designing and producing the weapon of warfare known as the 'Tanks,' as actually used, was to be attributed to Sir William Tritton and Major Wilson, who, in fact, carried out their work in the latter part of the year 1915 and the early part of the year 1916; and it was recommended that a large award of 15,000*l.* should be made to them. On the other hand, it was found that Mr. L. E. de Mole, an Australian engineer, had made and reduced to practical shape, as far back as the year 1912, a brilliant invention which anticipated, and in some respects surpassed, that actually put into use in the year 1916; and that this invention was, in fact, communicated at the time to the proper Government Department, but was not then appreciated and was put aside and forgotten. The result in this case was expressed as follows:—'We regret that we are unable to recommend any award to him. But we are bound to adhere to the general rule in such cases that a claimant must show a causal connection between the making of his invention and the user of any similar invention by the Government.' It need hardly be said that, had Mr. Mole's invention been brought either directly or indirectly to the notice of Major Wilson or Sir William Tritton, as was clearly not the case, a very different result would probably have been arrived at by the Commission."

From the foregoing remarks I think it will be apparent that the conditions affecting priority and validity of claims to discoveries in the case of unpatented inventions for war purposes are unsuitable for adoption in the case of any future provision for awards, not only in regard to medical and surgical, but also scientific, discoveries the publication of which is desirable in the national interest.

Mr. Tindal-Robertson's letter, to which reference is made above, concluded with the following statement: "I need hardly say that this letter in no way touches the broader question raised by the first paragraph of Sir Ronald Ross's letter—namely, whether some new body should be constituted for the purpose of recognising and rewarding discoveries or services such as are there referred to."

I venture to say that, as a condition precedent to the constitution of such a body, it is necessary to define the principles upon which priority in discovery should be established and the validity of claims to discoveries should be determined. I have suggested such principles in my scheme, and they resemble in certain respects the principles upon which priority in the invention of patentable inventions is established and the validity of claims to such inventions is determined on application for patents or on proceedings to revoke patents.

In my Memorandum G (p. 18) I observed: "Another potent deterrent to research is the absence of any trustworthy means of establishing claims to discoveries, and the contentions that frequently arise as to the validity of such claims must tend to make research workers less disposed to attempt to solve problems of fundamental importance."

In exemplification of this I referred to letters appearing in the *Times* that succeeded and had relation to the insertion in the issue of the *Times* of May 22, 1918, of an article from a correspondent on the subject of trench-fever research, and reference was made in the correspondence to the Commissions on Malta fever, sleeping sickness, and trench fever.

I may mention that trench-fever research might have been promoted during the war by the allocation of grants (to be administered under conditions similar to those specified in my scheme) to unremunerative discoveries which advance the knowledge of the causation, prevention, or treatment of trench fever.

I may add that co-operative research, as well as the research of individuals working independently, can be promoted in accordance with the principles of my scheme. Priority in discovery could be established on similar conditions in both these kinds of research, and research by a co-operative body might be encouraged, without causing jealousy among the co-operative workers, by their agreeing to assign prospective grants to a nominee empowered to hold such grants for the purposes of the research. WALTER B. PRIEST.

Gresford, Wrexham, November 28.

The Smoke-veil.

A curious instance of atmospheric pollution came to my notice on November 26 while walking from Hayfield into Edale over the central watershed of England in the Peak of Derbyshire. Below 1500 ft. on the western side there was hazy sunshine with a rime frost, but at this level we entered a thin cloud, with a temperature scarcely below freezing point, formed by a steady easterly wind blowing over the Peak plateau from the east. Friends in Edale informed us that these conditions had obtained since the morning of the previous day, and the hoar-frost thus formed was peculiar; the stream-lines of air-flow round stones were clearly mapped by curling lines of ice, while every blade of grass and stem of Juncus bore a deposit of ice-crystals which resembled the

blade of a knife, the knife-edge pointing up-wind and the parent leaf forming the back.

On the largest of the ice-knives, which approached an inch in width, a regular striped pattern was evident, even from a distance of two or three yards, and closer inspection showed the same stripes on every one. These stripes were three in number, pale grey near the leaf, and again grey towards the edge of the knife, with an intervening zone of clear or yellowish ice. The grey stripes were evidently due to the presence of smoke in the cloud-mist during the daytime on November 25 and 26, while the clear zone between had been formed from the cleaner night-wind.

At Edale Cross, 1750 ft. above sea-level, the undamaged knives pointed their edges due east magnetic or directly to the centre of Sheffield. The intervening distance is more than sixteen miles, of which the first fourteen miles traverse some of the wildest moorland in England. Though I became familiar with the fouling effect of our industrial towns even on this lonely hill-country during nearly two years' residence there, yet this particular example seemed strange enough to be recorded.

W. LAWRENCE BALLS.

The Orchard House, Bollington Cross,
near Macclesfield, December 1.

An Oyster Spat (1921) with Mature Male Sexual Products.

IN the course of experiments carried out this year (1921) on the rate of growth of the slipper-limpet in the River Blackwater, Essex, I obtained a number of oyster spat on shells put in a floating raft and on clean scallop shells which were put in the water on June 9. These clean scallop shells were strung out on tarred rope at low water and kept suspended above the ground by tying the rope to stout branches of trees driven vertically into the ground. On November 16 the shells were taken out of the raft and from the shore and the new summer growth, including young oysters, examined and measured. Many of the young oyster spat measured about an inch in diameter (length anatomically) and an inch in depth (height anatomically). Some of these living spat were examined microscopically on the beds, and a few were taken back to the Plymouth Laboratory for careful examination in the living state.

In one of the spat examined at Plymouth a few ripe sperm-morulæ were found, which disintegrated into active separate sperm while under observation under the microscope. In order to confirm this interesting observation microscopic sections were prepared, and some ripe sperm-morulæ found actually in the gonadial tubes. It is therefore established that oyster spat may produce ripe sexual products in the year in which they are born. In the experiment described here the oyster which gave mature male products had a *maximum* age of twenty-three weeks; it was probably younger than this, but there is no means of determining how much younger it actually was. In a paper by the present writer ("Sea-temperature, Breeding, and Distribution of Marine Animals," Journ. Marine Biol. Assoc., vol. 12, No. 2, p. 352, 1020) it was predicted that "young specimens of the European oyster (*O. edulis*) will be found to be sexually mature in the summer in which they are spawned in those situations where high temperatures obtain for a few months." The exceptionally warm summer of 1921 resulted in an unusually long breeding period for oysters and in "high temperatures" prevailing over English oyster-beds for several months. In 1921, therefore, the conditions over English oyster-beds compared with normal conditions in such oyster-breeding places as Arcachon, Taranto (Italy), and the spatting pools in Norway.

The observation here recorded is of considerable academic interest, and might become of practical interest when confirmed—as I have no doubt it can be—in a large number of specimens. Between September and November this year I have been able to examine only eight large 1921 spat, including those mentioned above. Most of them gave indications of developing sperm, but in such small quantity that microscopic sections are required of them all for confirmation. The young oyster containing ripe male sexual products was not ripe in the sense that all the gonadial tubes at the surface of the body were crammed with tailed sperm-morulæ; and although there can be no doubt that the sperm from this young oyster were mature and were capable of effecting fertilisation under suitable conditions, it is not thought probable that ripe sperm are actually extruded by such small forms. There can be no doubt, however, that similar spat would be fully mature in the following summer, and would certainly breed at least as males. This experiment, which was made possible by a grant from the Royal Society, is being continued, and should yield—together with a large amount of spat now isolated from other localities—further useful material for investigating the sex of oysters at first maturity. The gonad of the young oysters examined in all cases indicated maleness, but the number examined is far too few to be of any value statistically. It is desirable to know the sex at first maturity of 1000 young oysters, and as young oysters have been more plentiful in most localities this year than for a good many years, it is probable that spat born this year can be identified with certainty now and isolated for examination next year. The sex of 1921 spat could be more easily determined in a large number of individuals next summer, and if results were recorded with accuracy from many different localities we should obtain a total of information which would help to clear up the doubtful question of the sex of the European oyster at its first maturity.

J. H. ORTON.

Marine Biological Laboratory, The Hoe,
Plymouth, December 5.

The Flight of Thistledown.

MY attention has been directed to the letters in NATURE of October 20 and November 10 on the flight of thistledown. The explanation of the phenomenon observed seems to me to lie in the very slow air-currents which are sufficient to raise the pappose structures of many Compositæ, especially when it is only the pappus which is raised, the fruit having fallen off.

Interested readers will find the hydrodynamics of fruit dispersal by wind discussed in some detail in my "Origin and Development of the Compositæ" (Wheldon and Wesley, London, 1919), and more briefly in my "Text-book of Botany" (Churchill, London, 1921). Some of the results given may be of general interest, *e.g.* the minimum winds which will raise the following pappose fruits (with fruit attached) are: dandelion, 1 m.p.h., groundsel, ⅔ m.p.h. The pappus alone would be lifted by a much slower wind, as is shown by the fact that a current of air moving at 0·59 m.p.h. is sufficient to blow the complete fruit of coltsfoot for a considerable distance horizontally.

JAMES SMALL.

Department of Botany, Queen's University,
Belfast, December 2.

The Study of Agricultural Economics.[1]

By C. S. ORWIN, M.A.

IT is now about five and twenty years since research and educational work in agriculture began to be developed seriously in this country. Since that date a very great deal of effort has been expended in investigating the forces by which plant and animal life are controlled, and in bringing natural science to bear in every way upon the problems of food production. Work along these lines has been productive of most valuable results to the farmer; but at the same time the fact has been overlooked that, when all is said, farming is a business, and if it is to succeed as such it must be carried on with a clear regard for the economic forces which control the industry. So, whilst desiring nothing but the fullest recognition of work in the fields of natural science applied to the investigation of farming problems, I must express without any qualification the view that the equal importance of the study of these economic forces has never been adequately recognised.

Educational and research work in agriculture which takes no account of the dominant importance of economics must always be ill-balanced and incomplete, for farming business requires for its proper control a consideration of human relationships, of markets, of transport, and of many other matters which should come within the purview of the economist, as well as, or even more than, a consideration of questions regarding the control of plant and animal growth with which the man of science, in the limited sense of the name, is concerned. No one could wish to deny the need for the close and continual study of the soil and the means by which it can be made to produce more abundantly; no one could deny the need for research work in problems of animal and plant life. But the main concern of the farmer is to know not so much that which he can *grow* and how best to grow it as that which he can *sell* and how to sell it at a profit. Given the necessary capital and labour, conditions may be contrived under which any soil may be made to produce any crop; but the wisdom or otherwise of embarking upon any particular form of production can be determined only by a study of economic forces. In Bedfordshire, for example, considerable areas of very moderate land are met with given up to a most intensive form of agriculture; but land equally suitable for a similar form of farming may be met with in many other parts of the country which is producing not a tenth part of the value in food products nor employing a tenth part of the capital and labour, whilst at the same time the systems under which it is farmed are fully justified by the results.

The reason of the difference, as doubtless everyone realises, is that the land in the former case is so situated that it has access, in the first place, to supplies of organic manures on an abundant scale and at a cheap price, and, in the second place, to markets crying out for its produce, whilst one or both of these facilities are denied to the other areas. In the Chilterns district of Oxfordshire farming a generation ago was mainly directed to the production of corn and meat, and nothing that has arisen out of the work of the investigators along lines of natural science would have called for any radical changes in agricultural policy on these soils. But economic forces, inexorable in their effect, have brought about a revolution, and arable land previously under corn and sheep is now laid down to grass or occupied with fodder crops for the maintenance of the dairy herds which have replaced sheep throughout the area. Again, in the hill districts of England and Wales there occur combes and valleys admirably adapted by soil and climate to the production of potatoes, and the highlands of Devonshire and Somerset may be cited in illustration. In these places, however, in the majority of cases, even though good markets may exist—Somerset, for example, imports potatoes—the lack of transport facilities makes it impossible for the farmers to produce anything which does not go to market on four legs.

Coming last to the question of human relationships, we find that it is possible to organise much more intensive forms of agriculture than any of our own, which would be an enormous advantage to a consuming nation like Britain; examples of such are to be met with in varying degrees of intensity in many countries. The Chinese, one reads, have increased production per unit area to an almost incredible extent, and in a lesser degree a similar state of affairs exists in parts of France and in Belgium (so often held up to us in this country as a model of productive capacity which we should strive to emulate). But in all these places the results are achieved only by a prodigal use of labour. The nation gains, no doubt, in the volume of produce available for its consumption, but the individual producer, deprived under this system of the opportunity to apply his manual effort in conjunction with an adequate amount of capital and land, is sacrificed to the consumer's advantage, and is driven to spend himself, year in and year out, for a reward for his toil to which the British worker, with so many alternative openings in more profitable directions available for him under our industrial system, would never for one moment submit.

These few illustrations may serve to indicate the over-riding importance of the economic factor in farming just as in any other business. It is a common experience in industry that many scientific and technical processes are possible which are not profitable, and it is in the light of the profit that they leave that all of them must be judged.

[1] Abridged from the presidential address delivered to Section M (Agriculture) of the British Association at Edinburgh on September 12.

Economic conditions are subject to continual change, and the variations may be both sudden and extreme. This makes it the more needful to be continually recording experience and to examine it for the facts that emerge from which to obtain guidance for future policy. Much information is required both for national and individual guidance. Of late years, for example, there has been much advocacy of more intensive cultivation of the soil; it is said that by closer settlement and more intensive methods the production from the land could be much increased. On the other hand, there are those who advocate a development of extensive farming as being the only means by which to attract capital to the land and to pay the highest wage to the worker. Both sides to this controversy can and do produce evidence in support of their views, and some figures derived from a survey made by my colleague, Mr. J. Pryse Howell, will serve to illustrate both. The total area surveyed was 9,390 acres, divided into fifty-two farms of various sizes, and the region was selected by reason of the uniformity of the general conditions. All available data for each holding were collected, and after grouping the farms according to acreage the figures were thrown together and averaged for each group, with the following result:—

Production per Unit of Land and per Unit of Labour from Holdings of Various Sizes.

Group.	No. of farms in each group.	Average size of farms.	Average arable land per cent.	Altitude.	Average rent per acre.	Average men per 100 acres.	Sales per acre.	Sales per man.
	Acres.			Feet.	s. d.		£ s. d.	£ s. d.
I.	0–50	5	39	17	341–369	32 10	7·1	11 19 11	168 19 0
II.	50–100	10	78	22	319–384	33 0	6·4	9 19 2	156 2 0
III.	100–150	14	138	21	370–453	27 2	4·2	7 19 1	189 0 0
IV.	150–250	11	201	11·7	330–411	28 4	3·3	7 5 8	222 12 1
V.	over 250	12	356	18·0	286–435	26 5	2·6	8 4 4	316 19 0

It will be noted that the conditions under which the farming is carried on in the various groups show no material differences as between one group and another, except in the matter of area. There is a tendency for rent to fall as the size of the holdings increases, but it is not pronounced, and in one case (Group IV.) the percentage of grassland to arable land is considerably higher than in the rest; but, considering the variations which must be expected in the conditions prevailing over any area of fifteen square miles, it may be claimed that in respect of altitude, quality of land, and proportion of arable to grass the holdings in these five groups are fairly comparable. Taking the results as they stand, the fact emerges that employment and production vary inversely with the size of the holding, but that the production per man employed varies directly with the size of the holding. Thus, on one hand, the advocates of closer settlement and the intensive methods which must necessarily follow if men are to live by the cultivation of small areas of land would seem to be justified in that the results shown by the survey indicate the highest amount of employment and the greatest product-value in the smaller groups. On the other hand, the advocates of more extensive methods of farming can point to their justification in that it is clear that the efficiency of management is greatest in the larger groups if the standard of measurement be that of product-value per man employed.

However, it is clear that either party is drawing conclusions from incomplete data. The efficiency of any farming system can be judged only by an examination of the extent to which all the factors of production are utilised and balanced under it. Each of the assumptions made from the figures above ignores entirely the factor of capital. Land, labour, and capital are all required for production, and the *optimum* system of farm management is that which utilises all three together so as to secure the maximum result from each. If information were available as to the capital utilised in each of the five groups in the survey it might be found that in the smaller groups labour was being wastefully employed, and that an equal number of men working on a larger area of land with more capital, in the form of machinery equipment, would produce an equal product-value per unit of land with a higher rate of output per man employed. Equally it might be found that in the larger groups the use of more labour, or a reduction in the area of land, might produce the same product-value per man with a higher rate of output per unit of land. Obviously there can be no absolute answer to the question of what constitutes the most economical unit of land for farm production. The quality of land in certain cases, and market, transport, and climatic conditions in many more, make it impossible to determine even within wide limits the size of the holding on which the principal factors of production can be employed with maximum effect. Within similar areas, however, and in limited districts, much work can and should be done by agricultural economists to collect evidence on this point for the information of all concerned with the administration of land.

Another matter of the utmost importance to the farmer and to the public alike, and one which is crying out for investigation on a large scale, is the distribution and marketing of farm produce. Attention has been directed many times to the discrepancy between the price realised by the producer and the price paid by the consumer for the same article. In connection with market-garden produce, for example, the Departmental Committee on the Settlement or Employment on the Land of Discharged Sailors and Soldiers stated in their Report (Cd. 8182, 1916) that "the disparity between the retail prices paid for market-garden produce in the big towns and the small portion of those prices received by the growers is utterly indefensible. It demonstrates a degree of economic waste which would ruin any other industry." No evidence was published by the Committee as to the facts upon which this conclusion was based, but a recent inquiry made by the Ministry of Agri-

culture into the prices prevailing at various stages in the distribution of vegetables in London may be quoted in confirmation of it. Figures were collected to show the amount received by the producer, the wholesaler, and the retailers for various classes of everyday garden stuff, with results as shown below.

Producer's, Wholesaler's, and Retailers' Prices for Market-garden Produce, January, 1921.

	Cabbages, medium grade, per doz.	Cabbages, bottom grade, per doz.	Cauliflowers, top grade, per doz.	Sprouts, top grade, per 28 lbs.	Turnips, medium grade, per cwt.
	s. d.	*s. d.*	*s. d.*	*s. d.*	*s. d.*
Producer...	0 3	0 2½	3 0	3 6	3 0
Wholesaler	1 0	0 9	5 0	--	5 6
Retailers—					
(*a*) Stalls and barrows	2 6	2 0	6 0	—	14 0
(*b*) Suburban shops ...	3 0	2 6	8 0	—	14 0
(*c*) Stores and high-class shops ...	4 0	3 0	10 0	14 0	18 8

One has only to glance at the prevailing methods of distribution to realise their wastefulness. The street in which I live contains ten houses, and each day four milk-carts, three bakers' carts, three grocers' carts, and two butchers' carts deliver food to them. Twelve men, horses, and carts, not to mention a host of errand-boys on foot and on cycles, to deliver food to ten families!

At the present time labour problems afford a useful example of the need for further investigation of the economic problems of agriculture. The labourer is often blamed for results which are due to the inefficiency of the farmer as a manager. When wages were low it may have been that the labourer was the cheapest machine, but in proportion as his remuneration approaches more nearly to the standard of reward in competing industries, so will the necessity for making his work more productive be intensified. The value of the output from the farm per man employed is not the only measure by which to gauge the efficiency of the management, but is certainly one of primary importance. A man with a spade can dig an acre of land in about two weeks at a cost to-day of about 4*l.* 10*s.*; a horseman and a pair of horses can plough an acre in about a day and a half at a cost of about 1*l.* 15*s.*; a farm mechanic on a tractor can break up an acre in about a quarter of a day, and although in the absence of sufficient data the comparison cannot yet be completed by reference to the cost of motor ploughing, it is fairly safe to suggest that when all the factors are considered—speed, less dependence upon atmospheric and soil conditions, as well as actual cost—there will be a still further advantage to be derived by investing the manual worker with the control of mechanical power. Thus it may be that high labour costs to-day are due in many cases less to the inefficiency of labour and more to the inefficiency of management.

In a recent issue of the *Times* an agricultural writer expressed the view that if the means existed for determining the proportion of the net returns of agriculture accruing to-day to labour, it would be found that labour was taking an excessive toll of farming results. This view is probably very generally held, and it affords a good example of the misconceptions which may and do arise in people's minds in the absence of exact information upon which to base their assertions. This happens to be one of the questions which have been the subject of investigation at Oxford, though only on the small scale that the means at the disposal of the University have admitted. An investigation was made before the war of the distribution of the net returns of agriculture as between landlord, farmer, and labour. It was found that the proportions accruing to each of the three interests varied hardly at all, and that it would be safe to say that 20 per cent. of the total was going to the landlord, 40 per cent. to the farmer, and 40 per cent. to labour before 1914. Taking the above proportions, and calling each of these shares 100, the proportion of distribution between the three interests varied during the following six years as shown below:—

Distribution of the Net Returns from Farming between Landlord, Farmer, and Labour during the years 1913–14—1919–20.

Year.	Landlord.	Farmer.	Labour.
1913–14 (standard)	100	100	100
1914–15...	97	104	99
1915–16...	94	108	98
1916–17...	91	115	94
1917–18...	90	111	99
1918–19...	87	115	98
1919–20...	89	109	102

The figures are interesting in several ways. In the first place they seem to disprove the suggestion referred to above, that labour has been taking an undue share of the net returns from farming, for an examination of the figures in the "Labour" column shows that until the institution of the Agricultural Wages Board in 1917 the tendency was in the direction of a slight but steady reduction in the proportion coming to the workers; the effect of the Wages Board Orders was to steady this tendency and, ultimately, to bring labour back approximately to the position it occupied in 1913–14. If the figures could have been continued for another year it is likely that they would show a material increase in the workers' share, but, even so, it would be found that this increase had been achieved without reducing the farmer's share below his pre-war proportion. In the second place, the figures confirm the experience of landowners in that the landlord has received no part of the increased prosperity of farming, whilst, as everyone knows, his expenses of maintenance have enormously increased. Briefly, the situation is that, thanks to the Agricultural Wages Board (and its appointed members may take heart from the fact), the workers have been maintained in the same position as regards their share in the net returns as that in which they were before the war, whilst the farmer has received his share in the increase realised during the past few years, together with that which would have gone to the

landlord had the pre-war scale of distribution been maintained. Rents and wages under normal conditions are slow to adjust themselves to changes in farming fortune, and, except in a time of violent economic upheaval, it is right that this should be so, for if the landlord may be regarded as a debenture holder, and labour as a preference shareholder, then the farmer, as the ordinary or deferred shareholder, has to bear the brunt, and if he must take the kicks so also is he entitled to the halfpence.

Turning now from problems in which either the nation generally or whole classes of the industry are concerned, it may be stated that there are many economic problems arising on the farm itself in the solution of which the individual farmer should be able to derive help from the economist. Some of these problems are so simple that their solution should be obvious, but the fact remains that waste in its most easily eliminated forms is constantly to be met with on the farm. The need for the study of the economic use of manual labour has already been referred to in another connection, but, granted that the balance between the employment of land, capital, and labour on any farm has been established, cases are continually met with where labour is being mismanaged. It is a not uncommon practice at threshing-time to take the horsemen from their work to assist at threshing, and as this operation can be performed only in dry weather, it may be assumed that the horses might usually be employed on threshing days. With manual labour costing about 7*s.* 6*d.* a day and horses about 5*s.* a day, the advantage of hiring casual labour for threshing, even at high rates of pay, will be obvious when it is remembered that the horseman whose horses are standing idle represents a daily cost for the manual work performed by him of some 18*s.* On a Midland counties farm, where the maximum possible horse-hours in a certain week in November last were 238, the time actually worked by horses was found to be eighty-seven, owing to threshing operations, and the wastefulness of the labour-management in such a case is obvious. Again, employers in certain cases object to paying Saturday overtime to men willing to work, because overtime payments are at a higher rate than those for ordinary time, but they overlook entirely the fact that the Agricultural Wages Board provides no overtime payments to the horses, and thus the cheapest horse-labour on the farm is that performed on Saturday afternoon at overtime rates of pay to the horsemen.

Everyone realises, of course, the importance of keeping horses busy, but not everyone thinks how heavily the cost of manual labour is increased by idle horses. The maximum number of working days in a year is 312, a total obviously impossible of attainment in practice. Such records as are available show that the days actually worked by horses on the farm will not usually exceed four-fifths of the maximum. More time may be lost in summer than in winter, a fact not generally realised, and the period of maximum unemployment falls between haymaking and harvest. The busy seasons are, of course, the autumn and the spring, when the preparation of the ground for winter and spring corn is going actively forward. In the year 1918 figures were collected to show the percentage of days worked compared with "possible days" in each month on four farms distributed pretty evenly over England, and the results, thrown together, are as follows:—

Percentage of Days Worked to Possible Horse-days on Four Farms in 1918.

	Per cent.		Per cent.
January	67	July	38
February	82	August	65
March	77	September	78
April	74	October	80
May	70	November	67
June	56	December	64

Although the figures represent an average of four farms, it is noteworthy that the results on the individual holdings varied one from another in degree only, and that the months of maximum and minimum employment were the same in every case. The loss of time is far more serious than many people realise. The maximum possible horse-days in the year are 312, and the cost per day of the horses on the above four farms on this basis was 2*s.* 7*d.*, whereas, owing to the time lost, the cost on the basis of days worked was 3*s.* 7*d.* Whilst some difference is inevitable, so great a discrepancy as these figures reveal can be avoided by skilful management, and one of the tests of the farmer's efficiency is provided by an examination of the distribution of horse-labour throughout the year on his farm. His cropping and other work should be so contrived as to provide for the uniform utilisation of horse-labour month by month. Under skilful management the differences in the number of days worked by horses from year to year are extraordinarily slight. On an East Midlands farm, employing twenty-three horses, the days worked per horse during the past six years have been as follows:—

Year	1913–14	1914–15	1915–16	1916–17	1917–18	1918–19
Days worked per horse	250·25	247	243	236	243	244·5

It may be noted, in passing that figures such as those given for the seasonal employment of horse-labour emphasise the need for a study of the place of the agricultural tractor in farm management, for the busiest times of the year synchronise, more or less, with the seasons when the weather is more uncertain and suggest that the application of speedier mechanical power to field operations, in substitution for slower horse-power, would result in economic advantages in certain cases.

In connection with the study of economics on the farm the question of agricultural costings naturally suggests itself. Farmers, as a class; are not accountants and much less are they cost accountants, but this has not deterred many of them from taking part in discussions of farming costs which have been going on in the Press and

in the Food Controller's offices for some time past, and the confusion of thought on the question of what cost of production really is which these discussions have revealed is evidence of the need for study and education in costing processes. Few things can be of greater service to the farmer than scientific book-keeping carried out and interpreted with proper understanding, but few things can deceive him more than costing wrongly conducted or misinterpreted.

Lastly, I want to urge, and particularly before a gathering such as this, the importance of agricultural economics in agricultural education. The fact is realised, no doubt, by many teachers, but until a sufficient body of data bearing on the study of farm management can be made available to them it is impossible for them to give to the teaching of practical agriculture that solid economic basis which is fundamental, and the teacher is driven to include in his instruction much to which the economic test has never been applied and to exclude more for which no basis for teaching exists at all. Given the requisite body of information it would not only be possible but also necessary to recast the whole foundations upon which the teaching of practical agriculture rests.

Black Coral as a Charm for Rheumatism.

By PROF. J. STANLEY GARDINER, F.R.S.

MR. C. H. POWNALL, of Banjoewangi, Java, has sent to NATURE office a letter accompanying three bracelets made from the horny skeletal substance of a soft coral or Gorgonian, known to science as Plexaura. This forms great branched growths which are abundant on the outer or seaward sides of coral reefs at from 10 to 40 fathoms, but in protected situations almost reaching the surface. All corals are formed by anemones, and the one in question here possesses eight feathered tentacles round the central mouth. The original anemone of a "colony," as the whole animal is termed, settles on the bottom and buds off other anemones from its sides, these in turn giving birth to further children. All remain attached to one another by canals, so that the whole growth forms a single, many-mouthed animal. It takes the form of long branches, the whole simulating a broom-like shrub growing upon the bottom of the sea. The skeleton is in the centre of the stems, and consists of an axis of black, horny substance in each branch, surrounded by the living tissues of the anemones, these further strengthened by scattered spicules of carbonate of lime. Generally, the branches are regarded as belonging to some form of submarine plant, to which the name Akar Bahar is given in the Malay Archipelago.

The bracelets, which are the cleaned, horny axes of stems twisted into rings, are "credited with the virtue of curing rheumatism." "There are," says Mr. Pownall, "many doctors in the Malay Archipelago who advise their patients to make use of them. They acknowledge that the bracelets do good, although they cannot account for it. It has been suggested that the substance is radio-active. Personally, I can testify that, during a residence of forty-seven years in this part of the world, I have never met a person who has used one of these bracelets without deriving benefit from it. The bracelets are usually worn on the left arm. All natives are firmly convinced of their efficacy, and all seamen and others who are much exposed to the wet make use of them. They maintain that they must be used quite plain; any ornamentation of gold or silver renders them useless."

Rheumatism is, of course, one of those diseases which can have as many causes as there are weeks in the year. Any concretions in any part of the body, however caused, may give the regular symptoms. The close association of rheumatism with malaria is well known to every tropical traveller, and malaria is particularly rife among coast-dwelling people. In some cases the symptoms described by the malarial patient are such as are usually associated with rheumatism. The present writer, while living in a small tropical island, Rotuma, ran out of quinine, which he had found quite effective. His reputation, however, had been established by that time, and he then found a mixture of cascara, brown sugar, and methylated spirit equally good. Probably these bracelets, if he had had them, would have been quite effective to produce similar faith cures. They exhibit absolutely no trace of radio-activity, and are not composed of a substance which could produce any direct effect. A lady who is a victim to rheumatism has worn one of these bracelets for a month, with considerable comfort and a satisfaction which she herself laughs at.

The association of the bracelets with rheumatism in the Malay Archipelago is interesting, because the use of similar bracelets merely as articles of adornment seems to be widely spread among fisherfolk from Suez to the most distant islands of the Pacific. They are made either of the stems of some Gorgonian such as the above, or of the true black coral (Antipatharia), in which the central horny rod is slightly hollowed. In the Maldives, growths dredged up by the present writer, after he had taken what he required, were eagerly divided up by his native crew, and a large piece was taken by the Sultan's representative to be presented on his return to court. The ornaments made were exclusively used by the women. Other coloured Gorgonians obtained at the same time were quite neglected. One of the black sailors, originally recruited at Zanzibar, on

H.M.S. *Sealark* in 1905 always wore a pendant of black coral under his blouse, and all the black "boys" on board begged pieces from us "to keep them from drowning." Inquiries show, too, that black ornaments, bracelets, rings, and pieces strung into necklets are common on all coasts from Zanzibar to Singapore. They are usually described as wood, but, as it is stated that the ends overlap or that the bracelets or rings are spiral, they are probably of coral. A Japanese professor says that black coral is much valued in China and Japan, and largely used by coastal people for jewelry. Branched growths are not infrequently brought up on the hook when fishing outside coral reefs, but, while there are frequent indications of local use, there is no regular fishery for such as an article of commerce.

Rheumatism would seem to be particularly a "charm" disease. All over England a potato is carried in the pocket as a remedy, and several ladies residing in Cambridge derive great benefit from the permanent presence of horse chestnuts below their couches. Rings of metal—tin in many parts of the West—are a regular specific. One of the black bracelets in question has a decorative value of its own. We wonder, however, whether the ladies might not find Chinese jade a still better specific.

Obituary.

J. M. Dodds.

BY the death of John Macalister Dodds on November 13 last Cambridge has lost a great gentleman, while many people, both inside his college and outside, have lost a most kindly, helpful, and amusing friend. He took his degree as fifth wrangler in 1881, and returned from Glasgow to Peterhouse as bursar and mathematical lecturer in 1884, since when he had resided in college continuously. He lectured, as usual, on November 12, and was found dead in his chair the following morning. Apparently the only published paper he was connected with was one on the value of the B.A. unit of resistance (R. T. Glazebrook and J. M. Dodds, Phil. Trans., 1883).

On returning to Cambridge Mr. Dodds gave advanced lectures on the theory of sound for some years, in addition to his routine work, but henceforth his main interest lay in the theory of numbers, the theory of groups, and kindred topics. Particularly was he interested in the theory of numbers, and he worked at it incessantly. I have heard him say that he tended to lose interest when the continuous variable was introduced into that beautiful subject. Indications are not lacking that such feelings were shared by Gauss himself, but in reality the leaning of Mr. Dodds was towards ancient, simply stated, and difficult problems of a pre-Gaussian kind. He was extraordinarily astute, for example, in the application of Fermat's famous principle of infinite descent. Formal algebra, too, had a great fascination for him.

A word must be said of his generosity in working at a problem with a colleague; the algebraical avenue being left to him, Mr. Dodds was untiring in his efforts until the inquiry became hopeless or the question was determined. One habit of his is probably now obsolete; each long vacation he made a complete set of solutions of the Tripos papers that had just appeared. Younger generations do not, I think, regard that as being any longer a task that provides mental exhilaration, even supposing the problems come out.

This is not the place to dilate on the wide knowledge of books and human beings that vast reading and irresistible social powers had given Mr. Dodds, yet no account of him can be complete without an allusion to what was, it may be, the most marked feature in his attitude on general questions. He was an intense and innate conservative; the smallest suggestion of change always seemed to arouse his instant opposition. As he was an acute dialectician, this might easily have become exasperating, but he was so big, so strong, and so laughingly good-natured that the almost inevitable did not happen. If he sometimes laughed at others, he often laughed at himself. J. H. G.

WE regret to announce the deaths, on December 9, of LORD LINDLEY at the age of ninety-three years, and, on December 11, of LORD HALSBURY at the age of ninety-eight years. Both were elected fellows of the Royal Society under the special clause which permits the admission of members of the Privy Council—Lord Lindley on January 20, 1898, and Lord Halsbury on January 13, 1887. It may be recalled that Lord Lindley was the son of the late Dr. John Lindley, professor of botany in University College, London.

Notes.

ON Saturday, December 10, the Official Referee under Part I. of the Safeguarding of Industries Act gave his decision on the complaint that santonin has been improperly included in the list of goods upon which import duty must be paid. The drug is derived from flowers grown almost exclusively in Southern Russia and Turkestan, and is extracted by a simple process which does not appear to demand professional skill; its application is medicinal as distinguished from chemical, but the evidence on the question whether it should be regarded as a "fine chemical" was most conflicting, and emphasised the difficulty which may be experienced in defining a "synthetic organic chemical" within the meaning of the Act. After two hearings Mr. Cyril Atkinson, K.C., expressed the view that the word "chemical" is not a scientific term, but implies a

distinctive substance which is, generally speaking, brought into being by a chemical reaction, or primarily used for taking part in a chemical reaction; whilst "fine" chemicals are those which are manufactured by processes involving chemical skill. Furthermore, he ruled that santonin be removed from the list, on the ground that it is not brought into existence by processes of chemical action, and is not applied in chemical changes; thus its inclusion would not benefit the industry, but would only tend to raise the price of a useful drug.

WE regret to note that the *Irish Naturalist* has reached a very critical stage in its existence, and unless a practical scheme is forthcoming which will place the magazine in a better financial position, publication will cease at the end of the year. At present costs the annual loss is estimated at 50*l.* per annum. The *Irish Naturalist* has served for thirty years with conspicuous success under the able guidance of the present editors as the mouthpiece of students of natural history in Ireland, and we hope that a workable scheme will be evolved to save the periodical for future workers. But the general question is a much larger one. All magazines of this kind, with a special appeal and a limited circulation, are labouring under similar difficulties, and unless something is done many will be forced to cease publication. Raising the price only results in a reduction of the number of subscribers. It would be a thousand pities if they have to be abandoned. They perform a useful and valuable service in the stimulation of interest in natural history, and by the publication of the results obtained by local workers. We feel that the whole question is one which demands sympathetic consideration by one or other of the national scientific societies, such as the Royal Society, the British Association, or the Conjoint Board of Scientific Societies, or even by the Government itself through the Board of Education.

A CHADWICK public lecture on "The History of the Doctrine of Infection" was delivered by Dr. Charles Singer on December 8 in the Barnes Hall, Royal Society of Medicine. Dr. Singer pointed out that primitive folk regard everything as being "infectious"—that is, communicable—and believe that, by a process of "sympathetic magic," moral qualities and powers pass from person to person, and that physical attributes are similarly conveyed from object to object. Sanitary legislation among many primitive peoples is based on this doctrine of "sympathy." The classical writers of antiquity who deal with medical topics for the most part regarded epidemic diseases as being conveyed by an atmospheric element, or "miasma," and only a few diseases as being transmitted from person to person, while the laymen of the same period laid more stress on conveyance from person to person. From the twelfth to the sixteenth centuries medical teaching was mainly derived from Arabian writers, who adopted much the same view as the classical writers. In 1543 Hieronymo Fracastoro, of Verona, published a work, "De Contagionibus," in which infection was regarded as being due to small seeds or *semina*, too minute to be seen, but capable of multiplication, and specific for each infectious disease. These views became widely adopted, and the general phenomena of epidemics were closely studied, so that by the commencement of the eighteenth century the materials for a theoretical solution of the problem of the nature of infection were well-nigh complete.

THE Air Ministry has announced that the second Air Conference will be held at the Guildhall, London, on February 7–8 next. The conference, which will be opened by the Lord Mayor of London, will deal chiefly with the future of aviation, with special reference to its development as a regular and speedy form of commercial transport. The papers presented will be divided into two main groups, the one dealing with civil aviation in general and the other with technical problems. The whole of the second day will be devoted to discussions arising out of the previous day's papers. The Secretary of State for Air will preside during the civil aviation portion of the proceedings, and Lord Weir of Eastwood during the technical sessions. The principal paper on civil aviation will be read by Lord Gorell, Under-Secretary of State for Air, who will give a general account of progress at home and abroad, and will direct attention to the ways and means whereby the development of civil aviation may be best furthered; in this connection Lord Gorell will endeavour to enlist the practical co-operation of business and other interests. The chief technical paper will be read by Mr. F. M. Green, of Sir W. G. Armstrong, Whitworth Aircraft, Ltd. The London terminal aerodrome at Croydon will be open for inspection on February 6, and demonstrations of amphibian aircraft alighting on the Thames will also take place during the period of the Conference.

THE library of the Chemical Society will be closed for the Christmas holidays at 1 p.m. on Friday, December 23, and will reopen at 10 a.m. on Thursday, December 29.

ACCORDING to the *Times*, a report has reached Norway from Moscow that a Russian expedition, at present exploring in Siberia, has found the bodies of the two lost men of Capt. R. Amundsen's expedition near the mouth of the Yenisei river. These two men left the *Maud* in October, 1918, in the vicinity of Cape Chelyaskin in the hope of making their way to the fishing settlements on the Lower Yenisei, a distance of some 700 miles across the barren tundra. They carried dispatches from Capt. Amundsen. A Norwegian search expedition looked unsuccessfully for traces of the two men along the coast of north-western Siberia in the autumn of 1920, as soon as news from Amundsen reached Norway reporting their departure.

THE Massachusetts Institute of Technology is again without a president. Dr. Ernest Fox Nichols, who was inaugurated last June to succeed the late Dr. R. C. Maclaurin in that office, was taken ill immediately after the ceremony. The illness has resulted, his physicians report, in "certain physical limitations, some of them probably permanent," which would make it unwise for him to assume the responsibilities of the position. He has therefore sent in his resigna-

tion, which has been regretfully accepted by the executive committee. Dr. Elihu Thomson, chief engineer of the General Electric Co., who served as acting president after Dr. Maclaurin's death, has again been appointed temporary head of the institute. The physical disqualifications under which Dr. Nichols labours will not restrict his activities in the simpler life of scientific investigation, and he hopes accordingly to return to the research laboratory and to resume the work, connected with certain problems of lighting, which he interrupted to accept the offer of the presidency.

An account is given in the *Times* of a recent ascent of Mount Kilimanjaro, the extinct volcano in the Tanganyika territory of East Africa. Discovered by German explorers in 1848, the summit was first reached in 1889 by Dr. H. Meyer, and since then it has been scaled several times. The last ascent, which took place in October this year, was made by Messrs. C. Gillman and P. Nason. No great difficulty was encountered in reaching the Saddle Plateau, which, at a height of some 15,000 ft., separates the two peaks of the mountain, Mawenzi, the rocky one rising to 17,570 ft., and Kibo, the ice-capped one, rising to 19,720 ft. The rarefied atmosphere forced two of the party and several native carriers to give up the attempt at altitudes varying from 16,000 ft. to 18,500 ft. The top was reached only with difficulty on this account. Many photographs were secured. Mr. Gillman notes that a comparison of the actual extent of the ice with that indicated on Dr. Meyer's photographs proves a considerable shrinkage of the glaciers, especially on the south-east, east, and north side of the peak of Kibo.

The following are among the lecture arrangements at the Royal Institution before Easter:—Prof. J. A. Fleming, six lectures adapted to a juvenile auditory on electric waves and wireless telephony, beginning on Thursday, December 29. On Tuesday afternoons, commencing on January 17, there will be two lectures on "Physiology as Applied to Agriculture," by Dr. F. H. A. Marshall; three by Prof. H. H. Turner on "Variable Stars"; five by Sir Arthur Keith on "Anthropological Problems of the British Empire—Series I.: Racial Problems in Asia and Australasia"; and two by Dr. J. W. Evans on "Earth Movements." On Thursday afternoons Mr. Seton Gordon will give two lectures on "Mountain Birds of Scotland and Sea Birds and Seals"; Sir Napier Shaw, two on "Droughts and Floods"; Prof. A. G. Perkin, two on "Dyeing: Ancient and Modern"; Prof. H. Maxwell Lefroy, two on "The Menace of the Insect Pest: The Balance of Life in Relation to Insect Pest Control"; Dr. P. Chalmers Mitchell, two on "The Cinema as a Zoological Method"; and Prof. A. M. Hind, two on "Landscape Etchers: New and Old." On Saturdays there will be six lectures by Sir Ernest Rutherford on "Radio-activity." The first Friday evening discourse will be given on January 20 by Sir James Dewar on "Soap Films and Molecular Forces." Succeeding discourses will probably be given by Viscount Burnham, Sir Francis Younghusband, Prof. W. D. Halliburton, Dr. R. S. Watson, Prof. J. Joly, Dr. C. M. Wenyon, Prof. T. R. Merton, Dr. A. P. Laurie, Prof. F. G. Donnan, Mr. A. B. Walkley, and others.

The Report of the Committee on Ancient Earthworks and Fortified Enclosures issued by the Congress of Archæological Societies for 1920 indicates that the damage anticipated from military entrenchments and other activities during the war has not been serious. Attention is directed to the rapid destruction of the hill-fort at Penmaenmawr by a quarrying company, and it is pointed out that the Act contains no provision for the payment of compensation to the owners of any ancient monument who would suffer pecuniarily if it were taken over by the public. Bokerly Dyke, on the borders of Dorsetshire and Hampshire, is suffering greatly from the burrowing of rabbits, but it is not clear that this constitutes the "neglect" which would justify the Ancient Monuments Board in taking action for its preservation.

The seventh Scientific Report of the Investigations of the Imperial Cancer Research Fund, which has recently been issued, cannot be said to throw much further light on the problem of the causation and prevention of malignant disease, although its contents have much scientific value and represent a considerable volume of research work which may be preliminary to more important later results. Long-continued study of transplantable tumours in the mouse and rat has shown that many of the characteristics of these tumours are consequent on slight biological differences subsisting between the cells of the organism in which the propagable tumour arises, and the cells and fluids of the successive hosts of the same species in which it is growing. The minute and painstaking investigations detailed in this report on the fundamental physiological processes of normal and cancerous cells, although not completed, have great value. The experiments by Drs. Murray and Woglom described in the report are important as throwing light on the means by which cancer can be artificially produced and on the cell changes occurring in the affected parts. It may be hoped that continuation of this investigation will throw new light on the origin of cancer not artificially produced.

The Department of Public Health of the Ministry of the Interior (Egypt) have recently published an instructive report by Prof. W. H. Wilson on the nutritive values of rations issued to officials and other public employees. Owing to the fact that a considerable proportion of the protein is supplied as vegetable protein, it was necessary to estimate its biological value, and to this end the author has utilised the results of K. Thomas, although, as he remarks, these can be regarded as only approximately correct. Prof. Wilson bases his conclusions as to the sufficiency of a diet upon the following considerations. He holds that the daily intake of available animal protein should not be less than 40 gm., that the fat intake should not fall below 30 gm., and the gross Calories should vary from 2600 for sedentary to 3450 for moderate or "hard" labour. It appears that several

of the Ministry of Education's ration scales are defective, and all those of the Ministry of War. Respecting the latter he writes: "Presumably the men are able to supply themselves from a canteen; this, however, can hardly account for the low level of what is stated to be the active service ration." This latter is defective to the extent of 543 Calories in respect of available energy, 14 gm. on the fat account and 5·5 gm. of protein. The following remark is of interest: "In February, 1919, the writer recommended that, in view of the number of relapses and high mortality from pellagra among the patients at the 'Abbâsiya Asylum on a diet the protein biological value of which was 49·5 (the diet being satisfactory in other respects), that this should be raised to 60. The result has confirmed the correctness of the assumption upon which the suggestion was made, a very remarkable diminution having taken place in the incidence and mortality from pellagra."

THE Proceedings of the South London Entomological and Natural History Society for 1920–21 record a successful year's activities. The finances of the society are in a healthy condition, owing partly to the generosity of friends and to the fact that the membership has increased from 162 to 184. The present issue includes three papers of general interest to entomologists. In his presidential address Mr. K. G. Blair gives an interesting summary of the more elementary facts concerning hibernation in insects. Mr. G. E. Frisby contributes a short paper on the habits of the British Aculeata, and succeeds in compressing a large amount of information within a small compass. Dr. F. A. Dixey, in a paper entitled "Sexual Dimorphism," illustrates his remarks with reference to butterflies, in which the phenomenon is more evident as colour differences than as divergence of form.

THE report of the director of the New York Aquarium for 1920 is a record of useful work done and continued progress made by this excellent institution. The addition of a collecting boat to its equipment has made possible a great improvement in the exhibits, and increased facilities for maintaining and adding to the collections. Arrangements are already in hand for increasing the number of tanks and for enlarging several of the existing ones. The total number of species on exhibition now reaches 191, comprising mammals, reptiles, amphibia, fishes, and invertebrates. The most important of the recent additions are specimens of the alligator garfish and two female Californian sea-lions. The number of visitors during the year reached almost two millions, and the value of the institution for educational purposes may be gauged by the fact that nearly eight thousand school children visited the aquarium with their teachers. In addition to the work of maintaining its own collections, the aquarium also supplied more than eight hundred animals to thirty-four school aquaria, and sent a number of specimens of Limulus to the Zoological Society of Berlin, about half of which arrived in healthy condition.

THE Report of the Geological Survey Board and of the Director for 1920 (1921, price 1s.) shows the remarkable progress made by this national service under the care of the Department of Scientific and Industrial Research. Though the retirement of Sir Aubrey Strahan and of Mr. G. W. Lamplugh will be keenly felt, the staff, under the directorship of Dr. J. S. Flett, has been strengthened by the addition of two district geologists, six geologists, and three other officials. The importance of a revision of the mapping of the coalfields, and the renewed attention given to deposits of minerals of economic value, are responsible for this satisfactory development, which was fortunately secured before the claims of external trade and internal unemployment became so painfully urgent in the present year. A scientific branch with the traditions of the Geological Survey of Great Britain does much to justify itself among educated producers, whether they own the land or toil beneath its surface. The age has gone by when William Smith had to direct attention to the attractions and advantages of geology by remarking that "the search for a fossil may be considered at least as rational as the pursuit of a hare."

THE British Association has issued the twentieth report of its Committee on Photographs of Geological Interest. Prof. S. H. Reynolds, of the University of Bristol, as secretary of the committee, is glad to receive unmounted copies of any photographs recording noteworthy sections or exposures, or illlustrating the relations of geological structure to scenery in the British Isles, and the prints so sent are registered and preserved for reference at the Museum of Practical Geology, 28 Jermyn Street, London. The inquirer who desires a copy for his own use is referred to the author of the photograph. The list attached to the twentieth report includes a large series of half-plate and quarter-plate pictures from Gloucestershire by Prof. Reynolds, mainly illustrating the famous Carboniferous sequence in the Avon gorge, and forty-five half-plate views of glacial deposits in Suffolk by that keen worker, the late W. Jerome Harrison. Mr. J. Ritchie contributes a series illustrating the erosion due to a cloud-burst in Aberdeenshire in 1891. It is much to be desired that funds would allow of the issue with such lists of small photographic reproductions from the registered views; but this would, of course, be impossible at the present time. Geologists near London, at any rate, have the advantage of consulting a very valuable series of records in an institution which has always been a bureau of scientific information.

THE rainfall of Southern Rhodesia is the subject of a communication by Mr. A. H. Wallis, reprinted from the *South African Railways and Harbours Magazine*, September, 1921. A map gives the seasonal, or annual, rainfall for several districts, obtained from the average of all observation stations in each district, for the period of six years ending June 30, 1919. The rains fall generally between October of one year and April of the following year. There are 239 rainfall observation stations in the country, all with voluntary observers, although, as it is pointed out, Rhodesia has been only thirty years under white occupation. Mashonaland, with an area of 114,000

square miles, is divided into sixteen rainfall districts and has 151 observing stations. Matabeleland, with an area of 60,728 square miles, is divided into thirteen rainfall districts with a total of 88 observing stations. The average seasonal, or annual, rainfall, ending June, for the whole of Southern Rhodesia is 30·38 in., that for Mashonaland 34·07 in., and for Matabeleland 26·69 in. The heavier rainfall in Mashonaland is accounted for by its being closer to the sea coast, where it has more favourable opportunity of catching the precipitation from the moisture-laden winds which blow from the eastward. The average amounts of rain for the several districts given in the map do not appear very divergent, but the falls in the several seasons are said to be sometimes very different.

IN No. 17 of the Geophysical Memoirs of the Meteorological Office Dr. Chree discusses "Simultaneous Values of Magnetic Declination at Different British Stations." Of recent years the Meteorological Office has issued two-hourly readings of the magnetic declination at Kew, which are published during the ensuing week for the benefit of mining engineers and surveyors. The question has arisen as to how far the values and changes thus recorded are applicable as standards at distant stations in the British Isles. In order to throw light on the subject, Dr. Chree has made a large number of detailed comparisons between the daily magnetic changes at Kew, Falmouth, Eskdalemuir, and Stonyhurst. It appears that the irregular movements in declination recorded at any two British stations show a general similarity, and certain general relationships of a not very definite kind are found between the variations at the different observatories. There are, however, differences which are of importance where accuracy in surveying is required to within 10′ of arc. In any case, surveyors' observations taken during a time of short-period oscillations, as indicated by reference to observatory records, should be repeated.

IN the November issue of the Dutch periodical, *de Natuur*, Mr. J. W. Giltay, of Delft, describes an instrument, the "optaphé," intended to enable blind persons who cannot use the optophone (owing to their not having an ear for musical differences), to read common printed matter by *feeling*. Five selenium cells are mounted on a screen, and the enlarged image of the letter to be read slides over the cells. Each cell is connected with a relay and a battery. So long as the cell is illuminated, the armature is drawn towards the electromagnet, and a contact is open. As soon as the cell, or part of it, is darkened by a part of the (black) image of a letter, the magnet lets go the armature, and the contact is closed. This contact shuts the secondary of a small induction-coil, in the primary of which an interrupted current is circulating. A box receiver is connected with the secondary; so long as this secondary is shut by the relay the diaphragm vibrates. The tips of the five fingers of, say, the right hand are touching lightly on the diaphragms of five receivers. The combinations of the vibrations of those five telephones play the same *rôle* as the five tones of the optophone. The diaphragms are not circular; part of them has been cut off, as the usual diaphragm of a small receiver does not give sufficiently strong vibrations. For further particulars and illustrations reference should be made to the Dutch periodical.

A NEW light alloy bearing the name of "Silumin" has been placed on the market in Germany. According to the *Zeitschrift des Vereines deutscher Ingenieure* of November 5, this alloy, which was exhibited at the recent motor show in Berlin, contains 14 per cent. silicon and the remainder is aluminium. It has a specific gravity of 2·5–2·65, *i.e.* 10 per cent. lower than the usual alloys of aluminium–copper–zinc. The tensile strength is 12·7 tons per sq. in., which is 25–30 per cent. higher than that of the alloys mentioned, while the elongation (5–10 per cent.) is double that of the common alloys. The tensile strength decreases slowly with rise in temperature. At room temperature, silumin has a hardness figure of 60 kg. per sq. mm. (38 tons per sq. in.) with a load of 500 kg. and a 10 mm. ball, and at 350° C. 20–25 kg. per sq. mm. (12·6–15·7 tons per sq. in.). It remains impervious to saturated steam, while dilute (25 per cent.) nitric acid, and even concentrated acid do not attack it as much as they do pure aluminium. In the presence of other acids and alkalies, it behaves much the same as pure aluminium. The thermal conductivity of silumin is to that of pure aluminium as 4 : 4·7, while the thermal expansion coefficient is 0·88, taking that of pure aluminium as 1. Silumin is produced by combining the two constituents, with certain additions, but it can also be manufactured electrolytically in the same way as pure aluminium. After manufacture it is "refined" by appropriate treatment.

A PAPER read by Dr. James W. French before the Optical Society on November 10 contained data relating to the interocular distance of 409 individuals tested. For men over eighteen years of age the average interocular distance recorded was 63 mm.; the smallest value was 56 mm., and the largest 72 mm. For women the mean value was 61 mm., *i.e.* 2 mm. less than the average interocular distance of the men. The smallest separation recorded was 54 mm., 2 mm. smaller than the smallest male value. The maximum separation was 67·5 mm., *i.e.* 4·5 mm. smaller than the highest male value. For adults of both sexes the average interocular distance was 62 mm. After seventeen years of age there does not seem to be any definite change in the average interocular distance of male adults. At fifteen the average was found to be 59·6 mm., and at sixteen, 61·4 mm. From these measurements it is seen that binocular instruments adjustable between the limits of 56 mm. and 72 mm. would suit most users. Prismatic binoculars are usually made adjustable between the limits of 57 and 70 mm. This higher limit of 70 only excludes about ½ per cent. of the total number of individuals tested. The lower limit of 57 excludes a larger proportion, namely 1¼ per cent., the total excluded by these extreme limits being, therefore, only about 1¾ per cent.

It would not seem desirable to prejudice the design of a prismatic binocular by attempting to suit this small proportion of extreme cases.

A PAPER on sea casualties and loss of life, read by Sir Westcott S. Abell before the North-East Coast Institution of Engineers and Shipbuilders on November 4, gives a very interesting analysis for the period of twenty-three years immediately preceding the war (1890–1913). From the results of this analysis, which are displayed both in tabular and graph form, it appears that the chance of loss of life of a passenger by reason of marine accident is about 0·02 per cent. Further, if it were possible to attain absolute perfection in the ship herself, then the reduction in loss of passenger life would amount to 70 per million passengers carried per annum. If, however, the location of casualty and the fact that technical ship and machinery regulations cannot provide against strandings and certain miscellaneous risks be considered, it would be possible to reduce loss of life to 30 per million per annum. Taking the whole twenty-three-year period, the number of deaths of passengers at sea from disease is nearly four times the number arising from marine accidents. The average death-rate from all causes for European seamen engaged in foreign trade in British vessels is about 4·0 per thousand, and the occupational risk is about 2·0 per thousand. The risk to underground workers in mines was about 1·7 per thousand in 1913, and averaged 1·5 per thousand from 1890–1900.

MR. D. E. PYE-SMITH, of Gonville and Caius College, has become a partner in the firm of Messrs. Bowes and Bowes, booksellers, Cambridge, which will continue to be carried on under the present title.

THE latest catalogue (No. 90) of second-hand books issued by Messrs. Dulau and Co., Ltd., 34 Margaret Street, W.1, gives particulars of upwards of 1600 works on botany, fossil plants, and agriculture, many formerly the property of the late Prof. Ph. van Tieghem, Paris. The list should be useful to librarians and others. We notice that, in addition to the foregoing, Messrs. Dulau are offering for sale many autograph letters of eminent men of science collected by the late Dr. Henry Woodward and Prof. Rupert Jones.

MESSRS. H. K. LEWIS AND CO., LTD., 136 Gower Street, W.C.1, have just published a short illustrated account of the establishment and progress of their seventy-seven years' (1844–1921) work as medical and scientific publishers and booksellers. Though the pamphlet refers particularly to the medical aspects of the business and the technical and scientific sides of the bookselling and library departments are referred to only briefly, for many years books on all kinds of manufactures have come within the scope of the firm's activities.

Our Astronomical Column.

FIREBALLS.—Mr. W. F. Denning writes:—"On Sunday, December 4, a large fireball was observed by Mr. E. H. Collinson from Ipswich at 10h. 10m. p.m. It was estimated to be several times brighter than Venus, and its path was from 288+67° to 279+51°; it moved swiftly, and left a silvery streak along its flight.

"A large and very brilliant meteor was viewed from Eastbourne and other places on Wednesday, December 7, at 9.30 p.m. It illuminated the sky with a strong glare, and many persons mistook it for ball lightning. Exact particulars of the path of this object have not yet come to hand.

"Observations of the Geminid meteor shower were commenced from Bristol on the morning of December 10 at about 3 a.m. In one hour's watch sixteen meteors were recorded, of which eight belonged to the Geminid stream, the radiant point being well defined at 108+32½°. Bright meteors were seen at 3.4 and 3.56 a.m., but these belonged to other showers."

OBSERVERS' HANDBOOK, 1922 (BRITISH ASTRONOMICAL ASSOCIATION).—When it became known that the "Companion to the Observatory" was being discontinued, the British Astronomical Association decided to fill the gap, entrusting the work to the Computing Section, of which Mr. L. J. Comrie is director. The Handbook has just been issued at the price (to non-members) of 2*s*. Its aim is not to supersede, but to supplement, the use of the *Nautical Almanac*, very little space being given to matter contained there.

The conditions of visibility of the planets in the different months are exhibited graphically in a diagram. Phenomena of Saturn's satellites are given, having been computed by Major Levin.

Other subjects included are periodic comets, variable stars (the ephemeris of Algol is corrected by recent observations), double stars, of which a series of test objects is given, graduated for apertures from 1 in. to 10 in., meteors, occultations, etc.

There are also descriptive notes on objects of special interest in the stellar heavens, and extensive tables of elements and constants. In short, the handbook promises to be of great utility to observers of almost every class.

PERTURBATIONS OF SATURN'S RINGS.—Dr. G. R. Goldsbrough (Phil. Trans., A, vol. 222) examines the perturbations of the ring particles produced by Saturn's satellites. He neglects the oblateness of Saturn and the mutual actions of the ring particles, and then finds boundaries of the zones of instability produced by the separate satellites. The action of Mimas is predominant, owing to its nearness; he find that it should produce a division from radius 16·9″ to 17·64″ (heliocentric distances from Saturn's centre), the figures agreeing exactly with the edges of the great Cassini division. It should also produce a clearance from radius 20·2″ to its own orbit; the actual outer edge of the ring is at 20·0″. Dione should produce a clearance from Saturn's surface to 9·34″; the actual inner edge of the crêpe ring is at 10·83″. Lowell reported a black band between ring B and the crêpe ring, which the author ascribes to the action of Rhea. It is shown that the dissipative action in each case is most effective in the outer portion of the unstable zone. The author thus explains the failure of Titan to dissipate the whole of the bright rings, which lie in Titan's zone of clearance (extending from the planet to radius 29·94″), but in the portion where the dissipative action is weakest. The author concludes, however, that this action will eventually dissipate the whole ring.

The Mound-builders of Dunstable.

AT a meeting of the Royal Anthropological Institute, held on November 8, Dr. W. H. R. Rivers, president, in the chair, Prof. G. Elliot Smith and Capt. Guy Crowden read a paper on "The Mound Builders of Dunstable." After describing the results of excavations on one of the Five Knolls on Dunstable Downs, in which the remains of three cremated bodies were interred, probably in the Bronze age, the authors directed attention to the association of the tumuli with cultivation terraces, huts, and ancient roads, and suggested that the presence of flint suitable for implement making was the determining cause of the settlement of the people who built the huts and made the cultivation terraces on the Dunstable Downs. The convergence of the main roadways at this spot is also to be explained by the transport of the most valuable economic product of the Neolithic—and even also of the Bronze—age to places where such material could not be obtained locally. Attention was directed to the geographical distribution of cultivation terraces in Britain, and their remarkable association in so many places with the edge of the chalk; and the attempt was made to correlate these facts with the observations of Mr. W. J. Perry as to the causal relationship between the distribution of the megalithic monuments of Wiltshire, etc., and the flint-bearing edge of the same chalk zone further south. The plea was made for the fuller investigation of the relationship existing between ancient monuments and geological formations that produced substances valued by man in ancient times, and also for the investigation of the effects of the admixture of cultures revealed in the round barrows in different parts of the country.

The discussion which followed the reading of the paper dealt mainly with the question of terrace cultivation. The authors in the course of their paper had suggested that the employment of terrace cultivation on this site was due to a conservative instinct which continued to employ a traditional system of cultivation, originating elsewhere, and not necessitated by the conditions of the present site. Mr. Peake, however, suggested that terrace cultivation was a natural consequence of ploughing or hoeing on the side of a hill; these operations, in course of years, would be bound to produce terraces such as those known on the Downs as "shepherds' steps." Col. Hodson, on the other hand, pointed out that in Assam, also an area in which megalithic monuments occurred, terrace cultivation was practised by the Nagas, and the terraces, so far from being the result of the method of cultivation, were built up of set purpose when land was brought under cultivation. Mr. Mills also stated that the Sema Nagas, when urged by the administration to follow the terrace system, had stated that they were unable to do so, as they did not know the sacrifices for terrace cultivation. Mr. Strong said that in China terrace cultivation had been brought about by climatic changes. Owing to deforestation the climate had changed, and it had been necessary to introduce terraces with shale retaining walls.

Mr. Peake, in the course of his remarks, also dealt with the question of the roads which meet at or near Dunstable. He pointed out that the Icknield Way followed the junction of the chalk and the greensand, and suggested that while its course was determined by the position of the springs which were found at that junction, the course of Watling Street was determined by purely geographical conditions, and depended upon the position of the Dunstable gap. The site of the Dunstable settlement had been determined by the roads rather than *vice versa*. As regards the origin of megalithic buildings, he had begun to think we must look further east than Egypt, possibly in the Persian Gulf. A note recently published by Prof. Sayce in *Man* showed that the people of Akkad were interested in a tin-land at a very early date. It was possible, therefore, that the megalithic people were not Armenoids. The second stream of broad-headed invaders of this country were the "Beaker-folk," the centre of distribution of whose culture appeared to be Bohemia, or possibly Southern Russia, but it showed no trace of Ægean influence. He did not regard the authors' correlation of chalk and megaliths as convincing if the distribution in this country were taken as a whole. Mr. Crawford had suggested a more reasonable explanation of early settlement in pointing out that it depended upon the distribution of grassland and forest area. Chalk and limestone gave grassland areas, and were, therefore, the earliest to be peopled. Mr. Garfitt pointed out that the stone circles of Derbyshire did not comply with conditions suggested by the authors.

Prof. Elliot Smith replied briefly to his critics. He maintained that the position of the roads was determined by the occurrence of *suitable* flint, which was not found at any and every point; he failed to understand how a people such as the Elamites, who used brick and built no megalithic monuments, could have been responsible for the diffusion of the megalith; and pointed out that the Derbyshire stone circles were associated with copper.

Norwegian Meteorology.

(1) A PUBLICATION entitled "Nedbøriakttagelser i Norge," recently received from the Norwegian Meteorological Institute, contains information relative to precipitation at about five hundred Norwegian stations over periods of from 10 to 40 years ending 1915. The tables give mean and extreme monthly and annual values, as well as frequencies of occurrence of the various types of precipitation, while the charts show the geographical distribution of some of the tabulated elements. It will be seen that the days on which precipitation of 1/10 mm. or more is measured have a frequency of from 50 to 60 per cent. (per annum) in the western coastal regions, falling to 30–40 per cent. in the more easterly districts of the south and inland districts of the north. Great variability occurs, however, over comparatively small areas. Whereas Osland (Bergen) reports 1 mm. or more on an average of 197 days in the year, Ulstad, which is also in South Norway, but further east, records this amount on only 54 days.

The introduction to "Nedbøriakttagelser i Norge" is devoted mainly to a discussion of wind screens for rain gauges. The results of experiments show a general increase in the amount of precipitation measured when screens are in use, especially in winter.

(2) "Om veir og vind i Trondhjem." In this paper, which runs to about seventy pages, M. K. Håkonson Hansen summarises and discusses meteorological observations at Trondhjem during 30½ years (1885–1915), and presents numerous tables of mean and extreme values, including, among other things, an

analysis of precipitation in relation to wind direction. Southerly and south-easterly winds have the highest relative frequency, while south-south-westerly and west-north-westerly winds are the wettest; easterly winds are the driest. The mean annual temperature at Trondhjem for the 30½ years is 4·8° C. (=41° F.). The average for January and February is about −2½° C. (=27½° F.), and for July, the warmest month, 13·8° C. (=57° F.). There is a good range of variability, −26·1° C. (=−15° F.), having been recorded in February, 1899, and +35° C. (=95° F.) in July, 1901, the latter a remarkable value for the latitude.

(3) "Oversigt over Luftens Temperatur og Nedbøren i Norge (1918)." This paper contains mean temperature and rainfall tables for the year 1918 for Norway. January is shown to have been abnormally cold, especially in the North, where Karasjok was 8·8° C. and Alten 7·2° C. on the average below normal. June, except in the North, and September, were also cool, but temperatures for other months and also for the whole year, were generally above normal. The rainfall at Florø amounted to 2617 mm. (=103 in.) during the year, 481 mm. in excess of normal. Karasjok, however, with a total of only 224 mm. (=9 in.) was 161 mm. below the normal.

(4) "Om betydningen av, at der i Skandinavien oprettes aerologiske stationer," by Th. Hesselberg. In this paper the director of the Norwegian Meteorological Institute gives a brief survey of the present position and importance of aerological research, and urges the need for the establishment of aerological research stations in Scandinavia to take part in international investigations. He advocates a departure, however, from the present custom of observing on certain fixed days in the year, and proposes to make ascents only during the prevalence of interesting types of pressure distribution. Such an arrangement is certainly desirable, but likely to be difficult in practice.

(5) "Aarsberetning (1919–1920)." Much of the information contained in this annual report relates to purely administrative work. There is an account of the opening of a geophysical observatory on Spitsbergen and of the destruction caused by a severe storm. There is also a note on a comparison which was made at the end of 1919 between spectro-heliograph observations at Meudon (near Paris), and simultaneous magnetic observations at Haldde (N. Norway), and it appears that a connection was traced between calcium flocculi and the electric radiation occurring in aurora borealis and magnetic storms. Although the general cause of these phenomena remains unknown, the writer of the report expresses the view that terrestrial magnetic storms are a far more delicate test of solar activity than any solar phenomenon which can be studied by direct observation of the sun. J. W.

The Preservation of our Fauna.[1]

By T. A. COWARD.

THE preservation of a fauna or flora is a national and international duty. The main arguments for protection are: (*a*) economic—the argument of the commercial mind and of the Board of Agriculture; (*b*) æsthetic—mainly used in support of bird protection; (*c*) humanitarian—the argument against cruelty and the wastage of life; and (*d*) scientific—the desire to preserve all species or forms rather than individuals from extinction. The last, though the most difficult position to demonstrate logically, is the one which should carry most weight with the biologist.

Man is a competing animal, and in that aspect is justified in interfering with natural laws so far as is necessary for his welfare. But all such influence should be ordered by scientific and unprejudiced investigation of the inter-relation of animal life. Legislation and personal influence are the best methods of retarding or stopping the destruction of the fauna, but either without the other fails in its purpose. Public opinion, the aggregate of personal influences, is the creator and upholder of legislation. Protective measures have in the past frequently been framed for selfish ends, not for the sake of the object to be protected, hence the confusion in the legislation of to-day.

Normally, without the influence of man, a natural numerical ratio of individuals and species is maintained, for convenience termed the balance; famine or other causes adjust this balance in time of over- or under-population. Man by cultivation and domestication has so dislocated natural conditions that such balance is impossible. But there is, especially in civilised lands, an artificial "natural balance," in which man is one of the competing factors. This balance is constantly overthrown by man or his competitors; it should be readjusted whenever possible in so far as readjustment is in accordance with advance. Unwise or over-cultivation, as exemplified during the food shortage, caused certain unexpected results; the temporary cessation of checks to the natural increase of certain species, as shown during the absence of many men during the war, produces a surprising alteration in the status of many forms.

Man, by his very abundance, encourages the increase of such forms as depend upon him; many of these are inimical to his welfare and therefore must be combated. In his attitude towards the larger animals, especially where he treats them as legitimate objects for the increase of wealth or for the enjoyment of sport, he may easily destroy the very creatures he wishes to exploit. The artificial introduction of animals alien to any country is always dangerous, and has in the past been the cause of the crowding out or destruction of native forms; in the interests of a fauna this practice should be stopped. The unintentional introduction of many "pests" is almost entirely due to commerce; these hangers-on of civilisation should, so far as is possible, be controlled, as their presence is alike a danger to the human race and to other creatures.

[1] Abstract of the presidential address delivered to the Manchester Literary and Philosophical Society on October 4.

Researches on Food.

THE Report of the Food Investigation Board for 1920[1] records a considerable amount of research work of scientific interest and immediate practical value. The Engineering Committee of the Board has shown that of the two channels of heat loss through an insulator, the solid itself and the air enclosed in the spaces of the solid, the latter is far the more important. The specific conductivity of any particular substance, *e.g.* cork, depends much more upon the form and size of its air spaces than upon the specific con-

[1] Report of the Food Investigation Board for 1920. (H.M.S.O., 1921.) 1s

ductivity of the material considered as a continuous solid. It has also been demonstrated that the chief source of escape of heat from the surface of a wall is by convection currents. The Meat Committee has devoted particular attention to the conditions under which "black spot," caused by the fungus *Cladosporium herbarum*, develops in cold stores. Its prevalence on meat coming from the southern hemisphere during 1918–19 was correlated with the unusually prolonged period of cold storage due to war conditions. Apart from its unsightly appearance, no harmful effect could be traced to the growth. The Fruit and Vegetables Committee has carried out a great deal of research. Amongst other results we may mention the observation that only those fruits which lack the complete systems of ferments causing post-mortem changes in flavour and colour (strawberries, raspberries, black currants, red currants, and gooseberries) can be kept in a satisfactory condition for jam-making when frozen in contact with air.

Under the Oils and Fats Committee Dr. and Mrs. Robinson have continued their investigation of the synthesis of isomeric oleic acids. A synthesis of oleic acid is being attempted, and the ground has been cleared by the preparation of quantities of the starting materials. The preparation of suberic acid from ricinoleic acid has been improved, and the diethyl ester of this acid has been reduced with the production of octomethylene glycol and a small yield of hydroxyoctoic acid. Miss Gilchrist has continued an investigation of the constitution of the synthetic fats derived from mannitol and methylglucoside. In connection with the Canned Foods Committee, the work of Dr. Savage, recently published in the *Journal of Hygiene*, on the effects of putrefying meat upon the health of animals fed with it deserves mention. Very little obvious effect upon health was produced.

University and Educational Intelligence.

BRISTOL.—There was a large attendance in the council room at the University on Friday, December 2, when Dr. Lloyd Morgan was presented with his portrait, a gift from friends, colleagues, and students both past and present. The portrait was executed by Mr. Anning-Bell, A.R.A.

CAMBRIDGE.—The event of scientific importance in the term just completed was the opening of the Molteno Institute for Parasitology by Viscount Buxton. This is a research institute equipped and presented by Mr. and Mrs. P. H. Molteno, where Prof. Nuttall (unfortunately too unwell to attend the opening ceremony), his assistants, research students, and trained investigators from all parts will attack the many problems connected with the life-history of parasites and their reactions on their hosts. In addition to the regular facilities for experimental research, there is a good museum included in the institute.

MANCHESTER.—Prof. H. B. Dixon has intimated to the Council and Senate that it is his intention to retire from the Sir Samuel Hall chair of chemistry at the end of the present session. Prof. Dixon was appointed in 1886 to the chair rendered vacant by the resignation of Sir Henry Roscoe, and he has maintained ably the reputation of the chemistry department of the college now known as Manchester University. His special line of research has been the investigation of the rate of explosion in gases. It was his knowledge and experience of this branch of investigation which led to his appointment in 1891 to the Royal Commission charged to report on the explosion of coal-dust in mines, and also to the post of Deputy Inspector of High Explosives for the Manchester Area during the recent war. The scientific importance of his researches was recognised by the Royal Society in its invitation to deliver the Bakerian lecture in 1893 and by the award of a Royal medal in 1912. His wholehearted devotion to the Owens College, and later to the University, led him to take a prominent part on its academic boards, where the many-sidedness of his attainments were of invaluable assistance, particularly at the time of the establishment of an independent university in Manchester. Prof. Dixon intends to continue his researches in the chemical department of the University, where the elaborate equipment necessary for his investigations has been built up.

THE Salters' Institute of Industrial Chemistry has awarded forty-seven grants in aid to chemical assistants occupied in factory or other laboratories in or near London to facilitate their further studies.

APPLICATIONS are invited for the Gull studentship in pathology and allied subjects at Guy's Hospital Medical School. The studentship, value 250*l.* yearly, tenable for three years, is open to candidates under thirty years of age who have studied at the Medical School of Guy's Hospital. The latest date for the receipt of applications, which should be addressed to the Dean of the School, is Tuesday next, December 20.

THE Grocers' Company, with the view of encouraging original research in sanitary science, is offering three scholarships, each of the value of 300*l.*, *plus* an allowance for expenses, tenable for one year, but renewable for a second or third year under certain conditions. The election will take place in May next, and applications must be sent before April 1 to the Clerk of the Grocers' Company, Grocers' Hall, E.C.2, upon a form obtainable from the Clerk.

THE Institution of Naval Architects announces that the following scholarships will be open for competition in 1922:—Naval Architecture: Elgar (130*l.* per annum), Cammell Laird (150*l.* per annum), and Armstrong (150*l.* per annum). Marine Engineering: Parsons (150*l.* per annum) and John Brown (150*l.* per annum). The scholarships are open to British apprentices or students, and are tenable (subject to the regulations governing each scholarship) for three years at particular educational establishments. Full particulars may be obtained from the Secretary, Institution of Naval Architects, 5 Adelphi Terrace, London, W.C.2.

THE tenth annual Conference of Educational Associations will be held at University College, Gower Street, W.C.1, on December 28–January 7. A preliminary programme has been issued, and the following are among the papers which will be presented:—Education as a Mission, by Principal L. P. Jacks, at the inaugural meeting (to be held at Bedford College for Women, Regent's Park) presided over by the president of the conference, Lord Gorell, on December 28; Secondary Education through Handwork, by Mr. B. S. Gott, on December 31; Mental Tests and Mentality, by Prof. T. H. Pear, on January 2; The Effects of Competition on Plant Life, by Dr. Winifred Brenchley, and The Soil and Plant Growth, by Dr. E. J. Russell, on January 3; and Needs of the Modern University, by Prof. H. Laski, on January 4. The papers to be read to the Geographical Association have already been announced in NATURE of December 8, p. 483. On December 31 "Education as a Science" will be the subject of a joint conference at University College; Dr. J. C. Maxwell Garnett and Prof. J. Strong will take part in the discussion.

Calendar of Scientific Pioneers.

December 15, 1890. James Croll died.—Known for his writings on physical geology, such as his "Climate and Time," 1875, Croll was successively a joiner, an insurance agent, an assistant at the Andersonian College, Glasgow, and keeper of maps in the Geological Survey of Scotland.

December 16, 1798. Thomas Pennant died.—The author of "British Zoology" (1766), "British Quadrupeds" (1781), and "Arctic Zoology" (1785), Pennant, who was the friend of Linnæus, Buffon, and Voltaire, was one of the leading British zoologists of his time.

December 16, 1809. Antoine François Comte de Fourcroy died.—A teacher and organiser with a talent for oratory, Fourcroy did much to popularise the doctrines of Lavoisier among his countrymen, and with Lavoisier, Guyton de Morveau, and Berthollet published the "Méthode de Nomenclature Chimique," 1787.

December 17, 1907. Sir William Thomson, Baron Kelvin of Largs, died.—The son of James Thomson, professor of mathematics at Belfast and Glasgow, Kelvin was born in Belfast, June 26, 1824. After studying at Glasgow and Cambridge, and at Paris, where he came under the influence of Liouville and Regnault, in 1846 he was appointed to the chair of natural philosophy at Glasgow, a post he held with great distinction until 1899. Kelvin was pre-eminent in the realm not only of theory, but also of practical application. In pure science he did important work in thermodynamics, magnetism and electricity, hydrodynamics, and the theory of the æther. Besides co-operating with Tait in their famous treatise on natural philosophy, he wrote several hundred papers. As an inventor of delicate scientific instruments he was unrivalled. To him are due electrical measuring instruments of all kinds, the mirror galvanometer, siphon recorder, standard compass, and sounding and tide-predicting machines. He was president of the Royal Society from 1890 to 1894 and in 1892 was raised to the peerage. He is buried beside Newton in Westminster Abbey.

December 18, 1829. Jean Baptiste Pierre Antoine Monet de Lamarck died.—Lamarck is regarded as the founder of invertebrate zoology. His "Philosophie Zoologique" appeared in 1809, his "Histoire des Animaux Sans Vertèbres" in 1815–22. He put forward views on evolution and enunciated the doctrine of the transmission of acquired characters.

December 18, 1892. Sir Richard Owen died.—The first Hunterian professor of comparative anatomy, and later superintendent of the natural history collection of the British Museum, Owen was one of the greatest contemporaries of Darwin and Huxley. His anatomical and palæontological researches refer to every class of animal from protozoa to man.

December 19, 1887. Balfour Stewart died.—A meteorologist and magnetician, Balfour Stewart made important researches on radiant heat and spectrum analysis. He was director of Kew Observatory and then professor of natural philosophy in Owen's College, Manchester.

December 20, 1913. Julius Scheiner died.—An assistant to Schönfeld at Bonn, Scheiner, in 1887, joined Vogel at Potsdam, where he carried out a great variety of investigations in astrophysics.

December 21, 1912. Paul A. Gordan died.—A contributor to the study of the calculus of invariants and co-invariants, Gordan for many years held the chair of mathematics at Erlangen. E. C. S.

Societies and Academies.

LONDON.

Association of Economic Biologists, November 18.—Sir David Prain, president, in the chair.—E. J. **Butler**: Meteorological conditions and disease. The meteorological conditions known to influence diseases of plants are chiefly temperature, humidity, and radiation. The influences are most marked in Continental climates, as the amplitude and duration of the variations are greater than in countries like England. They act both on the host-plant and the parasite, but to judge of their full effect it is often necessary to test them on the host-parasite complex, since the influence on either host or parasite alone may not give a true picture of what occurs in the interaction of the two which constitutes disease. Small variations, amounting to not more than 5 per cent. in relative humidity or 10° C. in temperature, if prolonged, may be sufficient to determine whether a parasite will cause nearly 100 per cent. infection or none at all. In India the author has found that several diseases are so sharply restricted in their distribution by these factors that it is possible to demarcate the areas in which they cannot occur, and also those in which they occur only in special conditions arising in exceptional years, from those in which they normally occur every year. The same is true in the United States. Exact evaluation of the factors concerned is possible by rigidly controlled experimental methods, but not by field observation alone.

Faraday Society, November 28.—Prof. A. W. Porter, president, in the chair.—J. N. **Greenwood**: The effect of cold work on commercial cadmium. Chill-cast commercial cadmium undergoes spontaneous recrystallisation at the ordinary temperature without the application of cold work. Deformation hastens this change. Deformation at 20° C. softens chill-cast cadmium, and during the subsequent annealing further softening occurs. It is concluded that two forms of cadmium are being dealt with, and that the quick cooling has suppressed the transformation. Recrystallisation and hardness experiments indicate the position of the allotropic change to be in the neighbourhood of 60° C. This accords with Cohen's transformation $Cd_\alpha \longrightarrow Cd_\beta$. Spontaneous recrystallisation of cast unworked cadmium takes place suddenly after about twelve days, and the hardness falls continuously during the same period. This would appear to indicate a gradual change from Cd_β to Cd_α. A third modification has sometimes been obtained, but its range of existence has not been determined.—J. N. **Pring** and E. O. **Ransome**: Reaction between cathodic hydrogen and nitrogen at high pressures. The electrode potentials with metals during electrolysis indicate that an accumulation of gas at very high pressures occurs at, or immediately within, the surface of the electrode. When cathodic hydrogen is liberated in contact with nitrogen, particularly at high pressures, the conditions appear to be favourable to the synthesis of ammonia. With nitrogen at atmospheric pressure the mean percentage current yield of ammonia by direct union of the elements amounted to 0·04 per cent. At pressures of from 60 to 104 atmospheres it was 0·09 per cent. Experiments at from 300 to 500 atmospheres showed a loss of acidity, but no ammonia was indicated. The small quantity of ammonia formed at lower pressures is ascribed to a thermal action of the heated conductors. The results indicate that no reaction takes place between nitrogen and hydrogen liberated at the cathode.—F. H

Jeffery: The electrolysis of aqueous solutions of alkaline nitrites with a lead anode and an electrometric determination of the constitution of the complex anion formed. The plumbo-nitrite complex is $(Pb(NO_2)_4)''$ for small concentrations of lead in alkali nitrite solutions. Probably this is the only complex formed. The solid in equilibrium with solutions obtained from anolytes of certain concentrations is lead nitrite crystals, $Pb(NO_2)_2,H_2O$. The colour of these crystals is approximately the same as that of the solutions from which they are derived, showing that the plumbo-nitrite complex probably maintains its identity in the crystals. A direct way of testing this hypothesis would be by an X-ray analysis of the crystals; the $(Pb(NO_2)_4)$ group should form a pattern regularly repeated in three dimensions relative to the cationic Pb atoms.—T. C. **Nugent**: An inhibition period in the separation of an emulsion. The system investigated was a fairly concentrated emulsion of benzine in water containing known amounts of stabiliser, *i.e.* gelatin or gum arabic. If caustic soda solution is added immediately, then the separation of the benzine commences immediately; but if the emulsion is left undisturbed for some time before the caustic soda solution is added, the separation of the benzine is retarded. This time lag may be termed the "inhibition period." Probably after an emulsion is produced, the gelatin slowly forms protecting layers about the benzine particles, and therefore the stability of an emulsion increases with its age.—N. R. **Dhar** and N. N. **Mittra**: Induced reactions and negative catalysis. Induced reaction is proved to be of general occurrence. In oxidation reactions, negative catalysis takes place when the catalyst is readily oxidisable. The explanation offered is the hypothesis of the formation of intermediate compounds. Experimental evidence supports the view that one chemical change will either promote or induce another chemical change of the same nature.

Linnean Society, December 1.—Dr. A. Smith Woodward, president, in the chair.—W. Neilson **Jones**: Note on the occurrence of Brachiomonas. This alga, which appeared last year in rain-water pools at Regent's Park College, had previously been reported only from brackish water at Sheerness, Stockholm, and the Black Sea.—J. **Burtt-Davy**: The distribution of Salix in South Africa. In South Africa ten species or varieties are known, and in tropical Africa twelve, only one being common to both areas. Usually each species occupies limited areas in one particular drainage-basin, so that cross-pollination is practically impossible. *S. Woodii* may be the connecting-link by way of Pondoland, the Transkei, and Eastern Cape with *S. safsaf* in Rhodesia. Although the Orange River is isolated from Angola by the wastes of the Kalahari, it is possible that these species, or a common ancestor, came from the north when the Cunene discharged into the Orange by way of the Molopo.—M. **Christy**: The problem of the pollination of our British Primulas. Some thirty species of insect visit or frequent the flowers of the three British Primulas (*P. vulgaris, P. veris,* and *P. elatior*). A small proportion have long tongues and are able to effect pollination, but their visits to the flowers are comparatively rare, and inadequate for the perpetuation of these Primulas. Most other insect visitors are short-tongued bees, totally unable to effect pollination. Some Coleoptera frequented the flowers, and seem capable of pollinating them, though in an irregular manner. Night-flying moths were suggested as the agents of normal pollination—a surmise advanced by Darwin.

PARIS.

Academy of Sciences, November 28.—M. Georges Lemoine in the chair.—P. **Termier** and L. **Joleaud**: New observations on the "nappe de Suzette" formed of Triassic strata, issued from the Alps, and having covered at the Aquitanian period a part of the region of the Rhône.—P. A. **Dangeard**: The nature of the spherome in the plant-cell. Reply to a recent communication by M. Guilliermond.—G. **Mittag-Leffler**: Cauchy's theorem on the integral of a function between imaginary limits.—M. **de Sparre**: The yield of reaction turbines working under a variable load. Turbines are usually constructed to work under full load. Calculations are given for determining the efficiency under a reduced load, and also for modifying the design of the turbine, so that while sacrificing a small percentage of efficiency at full load the efficiency varies only slightly under large variations of load.—C. **Sauvageau** and G. **Denigès**: The efflorescence of marine algæ of the genus Cystoseira.—G. **Cerf**: The systems of Pfaff and the transformations of partial differential equations.—J. **Wolff**: The series $\Sigma\frac{A_k}{z-a_k}$.—E. **Borel**: Remarks on the preceding note.—G. **Valiron**: Integral functions and their inverse functions. C. **Camichel**: Hydraulic states of flow.—D. **Eydoux**: The variation of energy round a point of a rotating hydraulic machine.—G. **Fontené**: The two Lorentz coefficients of inertia for movements at high velocities.—E. **Belot**: The minor planets of the Saturn family.—Mrs. Isaac **Roberts**: A star which may have appeared in the sky since 1892.—J. **Le Roux**: Time in classical mechanics and in the theory of relativity.—A. **Dauvillier**: Analysis of the atomic structure. The author summarises the conclusions derived from his theory of atomic structure in a form of the periodic table of the elements, showing the number of the superficial electrons, the number of electrons, and the quanta.—E. **Rengade**: The resolution of a salt in the course of the isothermal evaporation of a solution. Reply to a criticism of M. Raveau.—A. **Kling** and A. **Lassieur**: The separation and estimation of copper, lead, antimony, and tin. The analysis of white metals. The method is based on the conversion of the tin into a complex stanni-fluoride, from which the sulphide is not precipitated by sulphuretted hydrogen, with later application of rapid electrolytic methods.—P. **Thomas** and G. **Carpentier**: A very sensitive reagent for copper: the Kastle-Meyer reagent. This reagent, an alkaline solution of phenolphthalein, originally proposed as a test for blood, is an extremely sensitive reagent for copper, and will show one part of copper in a hundred millions of water, and as ordinary distilled made with a copper still may contain one part of copper in a million, special precautions are necessary in applying the test. In a solution free from organic compounds the reaction is distinctive, and is given by no other metal.—P. **Robin**: The action of nitrogen iodide and cyanogen iodide on benzamidine.—C. **Mariller**: A method of fractionating liquid mixtures and its application to the preparation of a home-produced fuel.—P. **Gaubert**: The recrystallisation produced by annealing. The theories which have been put forward to explain the recrystallisation of metals have been applied to interpret the results of experiments on organic compounds, vanillin, paraffin wax, beeswax, and cetin. It was found that recrystallisation is, in general, only possible when the crystals are sufficiently malleable for mechanical actions to modify their crystalline network.—P. **Glangeaud**: The architecture of the three principal volcanic centres of the Cantal massif.—P. **Corbin**: The tectonic of the eastern edge of the

Vercors massif.—P. **Loisel**: The existence of a new radio-active emanation in the springs of Bagnoles-de-l'Orne and its neighbourhood. The experiments described can be best explained on the assumption of the presence of a new simple radio-active element, provisionally named emilium.—L. **Dunoyer**: The graphical determination of average wind velocities.—L. **Besson** and H. **Dutheil**: Relations between the direction of the cirrus clouds at Paris and the barometric situation in Europe. The results of an examination of ten years' statistics.—Miss Ethel **Mellor**: The lichens which attack glass and their mechanical action on stained glass windows of churches. The immediate cause of the corrosion of stained glass windows is the mechanical action of the lichens; this action follows on the chemical weathering of the glass, itself accelerated by the growth and life of the lichens. The remedy suggested is annual window cleaning.—L. **Plantefol**: The teratological spikes of *Plantago lanceolata*.—A. **Dauphiné**: The experimental production of acceleration in the evolution of the conducting apparatus. Experiments on the growth of the root of the lupin, from which certain parts have been removed.—F. **Obaton**: The comparative structure of leaves of the same age and different dimensions. In small and large leaves from the same branch and of the same age the histological elements are practically the same magnitude for the parenchymatous part, and are also nearly identical in the composition of the structure of the physiologically comparable veins.—P. **Freundler** and Mlles. Y. **Menager** and Y. **Laurent**: The composition of the Laminaria. The maximum proportions of iodine, carbohydrates, and brown pigments coincide with the period of maximum insolation.—G. **Bertrand** and Mme. M. **Rosenblatt**: The distribution of manganese in the organisms of the higher plants. A detailed study has been made of two plants, *Nicotiana rustica* and *Lilium lancefolium rubrum*, at different stages of growth. The maximum proportion of manganese is usually found in the organs where the chemical transformations are the most active. The seeds also contain a high proportion of manganese.—M. **Doyon**: The utilisation of the frog for the demonstration of the anti-coagulating action of the nucleic acids.—A. **Michel**: The fibrillary tissue and nerve tissue of the elytron and dorsal cirrus of the Aphroditian Annelids.—C. **Julin** and A. **Robert**: New observations on the formation of the cardio-pericardic organ and of the epicardium in the oozoid of Distaplia.—E. **Roubaud**: Fertility and longevity of the domestic fly. A minimum of 600 eggs is estimated as the average production of a normal fly, and taking the period of evolution from egg to egg-laying as eighteen days, and it may be as low as thirteen days, from May 1 to September 30 a single fly may give rise to 4000 billions (4×10^{15}).—A. **Gruvel**: Pearl oysters on the coast of Madagascar.—R. **Kœhler**: The services which radiography may render in the study of Clypeaster.—H. **Heldt**: The co-operation of the dirigible balloon in sea-fishing. The dirigible balloon has proved useful in rapidly sketching out the nature of the sea-floor, knowledge of use to the fisherman. Shoals of fish are also readily seen; the balloon can hover over the spot and send signals to the fishing fleet.—C. **Noiszewski**: Glaucoma and the relations between intra-ocular and intra-cranial pressure.—G. **Bourguignon**: The localisation of poisons and infections on the neuro-muscular systems of man according to their chronaxy.

MELBOURNE.

Royal Society of Victoria, September 8.—Prof. A. J. Ewart, president, in the chair.—J. **Shephard**: The Rotifera of Australia and their distribution. Two hundred and thirty species have been recorded as the result of the work of seven or eight observers. The wide distribution of rotifers may be regarded as due to man's agencies.—E. T. **Quayle**: Local rain-producing influences in South Australia. The greatest rain improvement area in South Australia owes its origin to Lake Torrens, while Lake Frome is the source of another area of probably equal improvement. The full plotting of this rainfall departure on a map showed marked rainfall deficiency both to northward and southward of the improved area, but ending abruptly at the lake, showing that it was not due to any specially favoured storm tracks. Several other lakes showed slighter effects of the same kind, proving that evaporation from the lakes was a very effective factor in rain production inland. Lakes Torrens and Frome were considered together. The probable run-off rainfalls and the percentage of rainfall finding its way into the lakes were considered to be increasing. The rainfall is not retained, as formerly, in numberless small reservoirs in the uplands, but is hurried down to the lower levels, and finally into lakes or swamps, which tend to improve rainfall locally. It is considered that the filling of Lakes Torrens and Eyre from the sea would make the whole area south-east of them capable of close settlement, especially when aided by proper use of the waters of the Murray and its great northern tributaries. One cause of Australian aridity is the growth of drought-resistant perennial vegetation which regulates evaporation adversely to storm demands for rain production, and prevents accumulation of water in inland lakes by its own moisture requirements and by its prevention of the formation by erosion of defined stream channels. Human occupation tends to improve climate by reason of forest destruction and the substitution of grass and crops for drought-resistant vegetation, by water storage, and the tapping of underground water supplies.—T. H. **Laby**: A new type of barometer.—T. H. **Laby**: A gravity metre.

SYDNEY.

Linnean Society of New South Wales, September 28.—Mr. G. A. Waterhouse, president, in the chair.—T. G. **Sloane**: Description of a new tiger beetle from the Wyndham district. A new species of Cicindela was described.—L. **Harrison**: Note on the pigmentation of frogs' eggs. Results are recorded of observations on the pigmentation of the eggs in some Australian species of the genera Limnodynastes, Pseudophryne, and Hyla.—E. W. **Ferguson**: Revision of the Amycterides. Part vii.: Hyborrhynchus and allied genera. A small group of genera having affinities both with the Acantholophus-Cubicorrhynchus and the Euomid complexes are dealt with.—C. T. **White**: Notes on the genus Flindersia (fam. Rutaceæ). The genus Flindersia, founded by Robert Brown in 1814 on *F. australis*, the common "crow's ash" of Queensland or "teak" of New South Wales, consists of eighteen species, fifteen of which are found in eastern Australia. The genus includes some of the most valuable timber trees of Australia.—A. B. **Walkom**: A specimen of Nœggerathiopsis from the Lower Coal Measures of New South Wales. A large specimen of Nœggerathiopsis showing radiate arrangement of the leaves was described. All specimens previously described with this arrangement have been obtained from the Upper (Newcastle) Coal Measures.—Marjorie I. **Collins**: The mangrove and saltmarsh vegetation near Sydney, with special reference to Cabbage Tree Creek, Port Hacking. The mangrove formation—the outermost—is characterised by the two species, *Avicennia officinalis* and *Aegiceras majus*; in the salt-

marsh—the inner—two plant associations, (*a*) Salicornietum and (*b*) Juncetum, are recognised. At Cabbage Tree Creek drift sand has been raising the level of the marsh for some years, and Juncetum, the marginal association of the saltmarsh, is invading Salicornietum.—A. M. **Lea**: Description of new species of Australian Coleoptera. Part xvii. Thirty-nine species are described as new, belonging to sixteen genera in the families Nitidulidæ, Malacodermidæ, Chrysomelidæ, Erotylidæ, Endomychidæ, and Corylophidæ.

Royal Society of New South Wales, October 5.—Mr. E. C. Andrews, president, in the chair.—A. R. **Penfold**: The essential oil of *Leptospermum flavescens* (Smith). This tea-tree grows extensively in the coastal and mountainous districts around Sydney. The average yield of oil is about 0·8 per cent. from the distillation of ½ ton of material. The principal constituents are α- and β-pinene, aromadendrene, eudesmene, dextro-rotatory eudesmol, leptospermol (new liquid phenol), small amounts of citral, and unidentified alcoholic bodies.—J. K. **Taylor**: A note on chemistry of Kurrajong seeds. A syrupy red oil was extracted from the seeds with a solvent; some could be obtained by subjecting them to pressure. The oil belongs to the semi-drying group of vegetable oils. The oilcake remaining after pressure treatment is comparable with other cakes.—C. W. **Mann**: Preliminary note on the occurrence of porphyritic intrusions at Yass, New South Wales. It was thought that these beds were flows of volcanic material which had issued contemporaneously with the formation of the interbedded sedimentary rocks. New evidence indicates that after the deposition of the sedimentary material the beds of porphyry were intruded into their present positions. The rocks occurring in the upper side of the shelf of porphyry are thin beds of breccia formed by the inclusion of fragments of sedimentary rocks while the molten magma was in process of intrusion towards the surface.

Cape Town.

Royal Society of South Africa, October 19.—Dr. J. D. F. Gilchrist, president, in the chair.—Miss M. R. **Michell**: Some observations on the effect of fire on the vegetation of Signal Hill. Within three weeks of a bush fire in February, 1919, which killed the aerial parts of plants, some had put up vigorous shoots, notably *Asparagus capensis*. They were perpetuated by regeneration from the underground parts or by seed. The fire stimulated erosion. It was favourable to the spread of the Rhenoster bush; no evidence of eradication of species by burning was obtained.—Miss A. V. **Duthie**: The morphology of *Selaginella pumila*. The species is an annual occurring in abundance near Stellenbosch. The base of the vegetative leaf contains well-defined aerenchyma communicating with the atmosphere by stomata which are confined to the aligular surface of the leaf and the leaf-margin. The roots are destitute of root-hairs, and contain an endophytic fungus.—A. R. E. **Walker**: Note on a specimen of *Phacops africanus*, Lake. A nodule containing an internal cast and a mould of the external surface of the thorax and tail of the trilobite *Phacops africanus*, Lake, was described. Each segment of the axis of the thorax bore a strong medium spine, and the thorax was composed of eleven segments.—J. W. C. **Gunn**, M. **Goldberg**, and J. H. **Ferguson**: A note on the pharmacological action of *Scilla Cooperi*, Hook. Fil., *S. Rogersii*, Baker, and *S. lanceaefolia*, Baker. Extracts of these South African species of squill have similar effects on frogs and mammals to the extracts made from the digitalis group, such as *S. maritima*, though they are less poisonous. They all contain glucosides.—C. S. **Grobbelaar**: I. Some South African Paramphistomidæ, Fisch. The conditions favouring natural infection of stock, the effects of infection, and the general distribution of the family in South Africa are noted. *Isidora* (*Physa*) *tropica*, Krauss, is the intermediate host of *Paramphistomum caticophorum*, Fisch. II. Some trematodes in the South African anura and the relationships and distribution of their hosts.—C. **Pijper** and H. **Zwarenstein**: The "Account Book" of Jan Haszing. Jan Haszing practised as a surgeon at Cape Town; his "Account Book" starts at 1736 and runs on continuously until 1767; it throws light on the life of Cape Town at that epoch.—J. **Moir**: Colour and chemical constitution. Pt. 16: Further miscellaneous observations. The position of the absorption band is given for ten further derivatives of benzhydrol, twelve further derivatives of phenolphthalein, five derivatives of quinolinic acid, eleven further triphenyl-carbinol dyes, and ten other substances connected with colour and fluorescence.

Books Received.

Obras Completas y Correspondencia Cientifica de Florentino Ameghino. Dirigida por Alfredo J. Torcelli. Volumen 1: Vida y Obras del Sabio. Pp. 309. Volumen 2: Permanos Trabajos Cientificos. Pp. 773. (La Plata: Ministère des Travaux Publics.)

A Treatise on Probability. By J. M. Keynes. Pp. xi+466. (London: Macmillan and Co., Ltd.) 18*s*. net.

Rays of Positive Electricity and their Application to Chemical Analyses. By Sir J. J. Thomson. (Monographs on Physics.) Second edition. Pp. x+237+9 plates. (London: Longmans, Green and Co.) 16*s*. net.

The Elements of Social Justice. By Prof. L. T. Hobhouse. Pp. 208. (London: G. Allen and Unwin, Ltd.) 10*s*. 6*d*. net.

British Astronomical Association: Observer's Handbook for 1922. Pp. 36. (London: Eyre and Spottiswoode, Ltd.) Members, 1*s*. 6*d*.; non-members, 2*s*.

A Handbook of some South Indian Grasses. By Rai Bahadur K. Ranga Achariyar. Pp. vi+318. (Calcutta: Butterworth and Co., Ltd.; London: Constable and Co., Ltd.) 4.8 rupees.

A Critical Revision of the Genus Eucalyptus. By J. H. Maiden. Vol. 5, Part 9. (Part 49 of the complete work.) Pp. ii+261–290+plates 200–203. (Sydney: W. A. Gullick.) 3*s*. 6*d*.

Physikalische Rundblicke. Gesammelte Reden und Aufsätze. By Max Planck. Pp. iv+168. (Leipzig: S. Hirzel.) 60 marks.

Nutrition de la Plante. By M. Molliard. I.: Echanges d'Eau et de Substances Minérales. Pp. xiv+305. II.: Formation des Substances Tenaires. Pp. vi+438. (Encyclopédie scientifique: Bibliothèque de Physiologie et de Pathologie Végétales.) (Paris: Gaston Doin.) 2 vols., 14 francs.

Chemical Reactions and their Equations: A Guide and Reference Book for Students of Chemistry. By Prof. I. W. D. Hackh. Pp. viii+138. (Philadelphia: P. Blakiston's Son and Co.)

Philosophy and the New Physics: An Essay on the Relativity Theory and the Theory of Quanta. By Prof. L. Rougier. Authorised translation from the author's corrected text of "La Matérialisation de l'Energie" by Prof. M. Masius. Pp. vi+159. (Philadelphia: P. Blakiston's Son and Co.)

Western Australia. Astrographic Catalogue 1900·0. Perth Section, Dec. −31° to −41°, from Photographs

taken and measured at the Perth Observatory under the direction of H. B. Curlewis. Vol. 13: Measures of Rectangular Co-ordinates and Magnitudes of 6879 Star Images R.A. 0^h to 6^h on Plates with Centres in Dec. $-35°$. Pp. 51. Vol. 14: Measures of Rectangular Co-ordinates and Magnitudes of 24,753 Star Images R.A. 6^h to 12^h on Plates with Centres in Dec. $-35°$. Pp. 113. Vol. 15: Measures of Rectangular Co-ordinates and Magnitudes of 22,139 Star Images R.A. 12^h to 18^h, on Plates with Centres in Dec. $-35°$. Pp. 107. Vol. 16: Measures of Rectangular Co-ordinates and Magnitudes of 19,277 Star Images R.A. 18^h to 24^h, on Plates with Centres in Dec. $-35°$. Pp. 94. (Perth: Observatory.)

The Tragic Sense of Life in Men and in Peoples. By Miguel de Unamuno. Translated by J. E. Crawford Flitch. Pp. xxxvi+332. (London: Macmillan and Co., Ltd.) 17*s*. net.

The War List of the University of Cambridge, 1914–1918. By G. V. Carey. Pp. xiv+616. (Cambridge: At the University Press.) 20*s*. net.

The Distribution of Gas. By Walter Hole. Fourth edition, rewritten and enlarged. Pp. xvi+699. (London: Benn Bros., Ltd.) 50*s*. net.

Traité d'Embryologie des Vertébrés. By Prof. A. Brachet. Pp. xvi+602. (Paris: Masson et Cie.) 60 francs net.

Notes sur les Propriétés fondamentales de la Matière. By Prof. J. Lemaire. Pp. 55. (Liège: Société Industrielle d'Arts et Métiers.)

Directive Wireless Telegraphy: Direction and Position Finding, etc. By L. H. Walter. (Technical Primer Series.) Pp. xii+124. (London: Sir I. Pitman and Sons, Ltd.) 2*s*. 6*d*. net.

Everyday Life in the Old Stone Age. Written and illustrated by M. and C. H. B. Quennell. (Everyday Life Series, I.) Pp. x+109. (London: B. T. Batsford, Ltd.) 5*s*. net.

Homework and Hobby Horses. Edited by H. Caldwell Cook. (Perse Playbooks, No. 6.) Pp. xii+58. (London: B. T. Batsford, Ltd.) 2*s*. 6*d*. net.

Iron-Founding. By B. Whiteley. (Common Commodities and Industries Series.) Pp. x+131. (London: Sir I. Pitman and Sons, Ltd.) 3*s*. net.

Applied Calculus: An Introductory Text-book. By F. F. P. Bisacre. Pp. xvi+446. (London: Blackie and Son, Ltd.) 10*s*. 6*d*. net.

Problemi di Filosofia Botanica. By Antonino Borzi. Pp. 344. (Rome: G. Bardi.) 60 lire.

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Relativisti Contemporanei: Vaihinger–Einstein–Rougier–Spengler–L'Idealismo Attuale–Relativismo e Rivoluzione. By A. Tilgher. Terza edizione. Pp. 81. (Roma: Libreria di Scienze e Lettere.) 3 lire.

La Loi de Newton est la Loi Unique: Théorie Mécanique de l'Univers. By Max Franck. Pp. iv+158. (Paris: Gauthier-Villars et Cie.) 12.50 francs.

The Framework of Wireless Telegraphy: A New Theory of Electric Wave Sources and Propagations, with Rational Applications. By R. C. Galletti di Cadilhac. Pp. 48. (London: Crosby Lockwood and Son.) 3*s*. 6*d*. net.

Department of Applied Statistics (Computing Section), University of London, University College. Tracts for Computors. Edited by Prof. Karl Pearson. No. 7: The Numerical Evaluation of the Incomplete B-Function. By H. E. Soper. Pp. 53. (London: Cambridge University Press.) 3*s*. 6*d*. net.

Diary of Societies.

THURSDAY, DECEMBER 15.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 4.30.—Major A. E. Milner: Diathermy in the Treatment of Lupus Erythematosus.

LINNEAN SOCIETY OF LONDON, at 5.—Prof. G. C. Bourne: The Raninidæ, a Group of Crustacea.—F. A. Potts: Narrative of the Carnegie Institution Expedition to Samoa.

NEWCOMEN SOCIETY (at King's College, Strand, W.C.2), at 5.—Annual General Meeting.—At 5.15.—R. C. S. Walters: Greek and Roman Engineering Instruments.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—J. H. Jeans: The New Dynamics of the Quantum Theory (Lecture). The following papers will be taken as read:—W. P. Milne: The Relations Between Apolarity and Clebsch's Mapping of the Cubic Surface in a Plane.—Miss G. D. Sadd: Certain Types of Plane Unicursal Curves.—H. M. Shaffer: The General Theory of Notational Relativity.—Pundit Oudh Upadhyaya: (1) Note on Gauss's Quadratic Identity; (2) A General Formula in Cubic Forms.—J. R. Wilton: Gibbs's Phenomenon in Fourier's Series and Integrals.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—Discussion on Paper by H. F. Collins: The Igneous Rocks of the Province of Huelva and the Genesis of the Pyritic Orebodies.—A. V. Reis: Underground Working of Wide Pyritic Orebodies.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Capt. F. M. Green: Development of the Fighting Aeroplane.

SOCIETY OF ARCHITECTS, at 6.

CHILD STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Miss von Wyss: Vital Elements in Art Teaching.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—L. H. A. Carr: Induction-type Synchronous Motors.

CONCRETE INSTITUTE, at 7.30.—E. F. Sargeant: (*a*) The Preparation of Concrete Aggregates; (*b*) Moving Forms.

CHEMICAL SOCIETY, at 8.—G. T. Morgan and J. D. Main Smith: Researches on Residual Affinity and Co-ordination. Part VII., Cobaltio Lakes of the Alizarin Series.

INSTITUTION OF AUTOMOBILE ENGINEERS (London Graduates' Meeting), at 8.—E. Chatterton: The Design of Automobile Clutches.

CAMERA CLUB, at 8.15.—F. F. Renwick: The Action of Dyes in Colour Sensitising and Desensitising Dry Plates.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE, at 8.15.—Dr. A. Balfour: A Medical and Sanitary Survey of Mauritius—Past, Present, and Future.

SOCIETY OF ANTIQUARIES, at 8.30.

FRIDAY, DECEMBER 16.

INSTITUTE OF TRANSPORT (at Royal Society of Arts), at 5.—J. Paterson: The Operation of a Road Distributing Agency.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—G Mitchell: Conveying and Elevating Machinery.—R. E. Knight: Discharge of Grain Cargoes in the Port of London by Pneumatic Elevators.

JUNIOR INSTITUTION OF ENGINEERS, at 8.—A. J. Simpson: Notes on Searchlight Construction and Operation.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 8.—L. Richmond: Address.

SATURDAY, DECEMBER 17.

PHYSIOLOGICAL SOCIETY (at London Hospital), at 4.—H. E. Roaf: (i) The Relation of Plant Pigments to Urinary Pigmentation; (ii) A Useful Modification of the Induction Coil; (iii) The Acidity of Muscle during Maintained Contraction.—W. A. M. Smart and H. E. Roaf: The Relation of Methæmoglobin to Oxyhæmoglobin.—W. A. M. Smart: A Simple Refractometer.—R. N. E. Condon: A New Drop-recorder.—H. E. Roaf: A Simple Method for the Detection of Nitrogen in Physiological Fluids.—G. Williamson: Note on the Resonator System in the Cochlea, with a Model.—T. Lewis, A. N. Drury, C. C. Iliescu, and A. M. Wedd: The Action of Quinidine on the Mammalian Auricle.—E. C. Dodds and J. McIntosh: Changes in the CO_2 Content of Whole Blood and Plasma produced by Meals.—V. H. Mottram: Growth of Cats on Various Pure and Mixed Fats.—H. Hartridge: Vindication of the Resonance Theory of Hearing.—D. T. Barry: Spontaneous Rhythmic Contractions of Flexor Type in the Dog's Hind Limb. Postural Influence, etc.

MONDAY, DECEMBER 19.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Meeting), at 7.—C. Poole: Worm-gearing.

ARISTOTELIAN SOCIETY (at University Club, 21 Gower Street, W.C.1), at 8.—F. Tavani: Physical Space and Hyperspaces.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.

TUESDAY, DECEMBER 20.

ROYAL SOCIETY OF MEDICINE, at 5.—General Meeting.

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—E. A. Rusher: Statistics of Industrial Morbidity in Great Britain: A Retrospect and a Scheme of Development.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—C. R. C. Petley: The Chamonix Valley (Lantern Meeting).

ROYAL GEOGRAPHICAL SOCIETY (jointly with the Alpine Club) (at Queen's Hall), at 8.30.—Lieut.-Col. C. K. Howard-Bury, G. L. Mallory, and other Members of the Expedition: The Mount Everest Expedition.

WEDNESDAY, DECEMBER 21.

ROYAL SOCIETY OF MEDICINE (History of Medicine Section), at 5.—C. J. S. Thompson: The Parturition Chairs—their History and Use.—Miss Eileen Power: An English Woman Doctor in the Fifteenth Century.

ROYAL METEOROLOGICAL SOCIETY, at 5.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—L. Owen: Notes on the Phosphate Deposit of Ocean Island, with Remarks on the Phosphates of the Equatorial Belt of the Pacific Ocean.—H. B. Milner: The Nature and Origin of the Pliocene Deposits of the County of Cornwall, and their Bearing on the Pliocene Geology of the South-West of England.

ROYAL MICROSCOPICAL SOCIETY, at 8.—E. A. Smith: The Microscope in Non-ferrous Metallurgical Research.—Dr. J. G. Parker and Dr. S. H. Browning: The Practical Value of the Microscope in Connection with Leather Manufacture.

PUBLIC LECTURES.

(A number in brackets indicates the number of a lecture in a series.)

THURSDAY, DECEMBER 15.

ROYAL COLLEGE OF SURGEONS, at 4.—F. W. Twort: Recent Researches on the Biology of Bacteria (Brown Lecture) (3).

UNIVERSITY COLLEGE, at 5.—Prof. J. E. G. De Montmorency: Religion and Feudalism (7).

LEPLAY HOUSE, 65 Belgrave Road, S.W.1, at 8.15.—Dr. C. W. Saleeby: Light against Death.

MONDAY, DECEMBER 19.

ROYAL COLLEGE OF SURGEONS, at 4.—F. W. Twort: Recent Researches on the Biology of Bacteria (Brown Lecture) (4).

KING'S COLLEGE, at 5.30.—Dr. W. R. Ormandy: Liquid Fuel Engines (5).

TUESDAY, DECEMBER 20.

ROYAL COLLEGE OF SURGEONS, at 4.—F. W. Twort: Recent Researches on the Biology of Bacteria (Brown Lecture) (5).

KING'S COLLEGE, at 5.30.—Dr. W. Brown: Psychology and Psychotherapy (10).

WEDNESDAY, DECEMBER 21.

SCHOOL OF ORIENTAL STUDIES, at 12.—Miss Alice Werner: Bantu Tribes of East Africa (6).

CONTENTS.

	PAGE
The Research Department	489
Gas Warfare. By S. J. M. A.	492
Zoology for Medical Students	493
The Study of Rocks. By Dr. J. W. Evans, F.R.S.	494
Our Bookshelf	495
Letters to the Editor:—	
The Action of Sunlight.—Sir Oliver Lodge, F.R.S.	496
Microscope Illumination and Fatigue.—H. J. Denham	496
Tin Plague and Scott's Antarctic Expedition.—Prof. Alan W. C. Menzies	496
The Dispersal of Snails by Birds.—Prof. T. D. A. Cockerell	496
The Distribution of Brightness in the Penumbra during an Eclipse of the Moon. (*With Diagrams.*) F. J. W. Whipple	497
Awards to Discoverers.—Walter B. Priest	498
The Smoke-veil.—Dr. W. Lawrence Balls	499
An Oyster Spat (1921) with Mature Male Sexual Products.—Dr. J. H. Orton	500
The Flight of Thistledown. Prof. James Small	500
The Study of Agricultural Economics. By C. S. Orwin	501
Black Coral as a Charm for Rheumatism. By Prof. J. Stanley Gardiner, F.R.S.	505
Obituary:—	
J. M. Dodds. By J. H. G.	506
Notes	506
Our Astronomical Column:—	
Fireballs	511
Observers' Handbook, 1922 (British Astronomical Association)	511
Perturbations of Saturn's Rings	511
The Mound-builders of Dunstable	512
Norwegian Meteorology. By J. W.	512
The Preservation of our Fauna. By T. A. Coward	513
Researches on Food	513
University and Educational Intelligence	514
Calendar of Scientific Pioneers	515
Societies and Academies	515
Books Received	518
Diary of Societies	520

NATURE

THURSDAY, DECEMBER 22, 1921.

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Carbon Monoxide in Public Gas Supplies

MORE than ordinary interest is attached to the Report before us,[1] inasmuch as it deals with issues of considerable importance from the points of view both of national economy and of public health. To understand the question involves not only some knowledge of the history and conditions of public gas supplies during the past century, but also a right perspective in our views as to the most economical solution of the domestic smoke problem.

For nearly eighty years after the establishment of the first public gas-works in London in the year 1813, the gas undertakings in Great Britain supplied their customers with what has been called a "straight coal-gas," or, in other words, with a gas obtained by the carbonisation of a bituminous coal (sometimes mixed with a small proportion of "cannel-coal") in retorts. In the early days of the industry, cast-iron retorts were employed, necessitating the use of comparatively low temperatures (650–750° C.) and the production of a rich lighting gas and a "soft" coke, which latter could be utilised effectively in domestic fire-places. It is significant that the name of the first London gas undertaking was the Gas Light and Coke Company, and that Frederick Accum, who in 1819 wrote the first descriptive treatise on the manufacture of coal-gas, was able to say that "the demand for coke in the capital, since the establishment of the gas-light works, has prodigiously increased. Numerous taverns, offices, and public establishments which heretofore burnt coal, now use coke to the total exclusion of coal; and in every manufactory which requires extensive lighting or heating, gas and coke are now the means jointly employed." It would thus appear that, a century ago, the London gas undertakings, by their enforced practice of carbonising coal at moderately low temperatures, supplied the public with two "smokeless" coal products, namely, gas for lighting and a soft coke for heating purposes, the *combined* use of which made possible the abandonment of the burning of raw coal in houses, offices, and public establishments.

As time went on, however, cast-iron retorts were replaced by those of fireclay in the gas-works, with the natural result that higher carbonising temperatures were employed. But even fifty years ago, when this change had become universal, the chief object of the gas undertakings still remained the production of a coal-gas of high self-illuminating power together with a coke of such "medium" porosity and texture that it would answer most domestic fuel requirements. The coal-gas of fifty years ago would probably contain (about) 0·25 per cent. of CO_2, 6·0 of CO, 5·0 of "heavy hydrocarbons," 40·0 of methane, 45·0 of hydrogen, and 3·75 of nitrogen, and its gross calorific value would be (about) 700 B.Th.U. per cb.ft., measured *dry*, at 60° F. and 30 in. barometric pressure.

With the rapid development, from 1890 onwards, of incandescent mantle gas lighting, which followed close upon A. von Welsbach's inventions in Germany (1885–95), and the concurrent increasing use of gas for cooking and domestic heating purposes, which were the outcome of Thomas Fletcher's pioneering efforts in this country, the need of a rich gas of high self-illuminating power diminished, and eventually almost disappeared. The demand arose for a cheaper gas of medium illuminating (say of 15–17 candle-power) but good heating power (say of about 600 B.Th.U. gross per cb.ft. at 60° F. and 30 in. barometric pressure). This led to raising the carbonising temperature in the retorts up to 1000° C. or more, and using "regenerative" methods of firing the retort settings, whereby some 12,000 cb.ft. of gas per ton of coal were produced, containing about 2·5 per cent. of CO_2, 6·0 of CO, 3·5 of heavy hydrocarbons, 33·0 of CH_4, 5·0 of H_2, and 5·0 of N_2, and having a *gross* calorific value up to about 600 B.Th.U. per cb.ft. at 60° F. and

[1] Gas Regulation Act, 1920. Report to the Board of Trade of the Departmental Committee on Carbon Monoxide. Pp. 12. (Cmd. 1422.) (London: H.M. Stationery Office, 1921.) 1*d.* net.

30 in. barometric pressure. As the carbonising temperature increased, however, the residual coke became gradually harder, and therefore less suitable for domestic consumption, especially in an open fire-place with low draught. Indeed the gas undertakings soon found themselves in the position of producing a coke which was neither a good domestic fuel nor yet a high-class, hard metallurgical coke, with the result that its profitable disposal was often a matter of difficulty.

An obvious way out was to convert part of the coke into "water-gas," by one or other of the processes which had been developed since the first Lowe plant had been installed in Great Britain at the Leeds Forge in the year 1888. And by mixing some water-gas with the coal-gas, a larger proportion of the potential heat-units in the coal taken into the gas-works could be sent out in the form of gas. Moreover, water-gas is cheaper to produce, and has an even higher calorific intensity (flame temperature), although the thermal efficiency of its production is somewhat lower, than that of coal-gas. Another important advantage about water-gas is that the plant for producing it occupies a much smaller area than a coal-carbonising plant for equal gas-therm yields; and, moreover, its operation is so comparatively easy and labour-saving that, to the harassed gas engineer, it is "a very present help in time of trouble," *e.g.* when coal supplies are unduly short or the demands of labour excessive. Up to the outbreak of the war, however, British gas undertakings had been commendably chary in using water-gas; indeed, it is probable that in the year 1913 the proportion of water-gas sent out did not, on the average, exceed (if it was as much as) 15 per cent. of the whole gas output of the works. The public would, in that year, be supplied with a gas of an average gross calorific value of about 575 B.Th.U. per cb.ft. at 60° F. and 30 in. pressure, of which the content of carbon monoxide did not exceed 15 per cent. at the most, and more probably in the majority of cases would not be greater than 10 per cent.

It may here be mentioned that in the United States, where the manufacture of water-gas originated in 1885, the policy of converting the coke into water-gas and of carburetting the latter with oil-gas had, long before the war, been pushed almost to its extreme limits. Thus New York had long been supplied with a mixture of about one part of "coal-gas" with as much as six or seven parts of "carburetted water-gas"; Chicago with a mixture of one to five parts; Boston with a mixture of equal volumes, and so on. In 1917, the New York gas contained, on an average, about 3·0 per cent. of CO_2, 27·0 of CO, 12·5 of heavy hydrocarbons, 20·0 of methane, 30·0 of hydrogen, and 7·5 of nitrogen; and its average calorific value would probably be about 675 B.Th.U. per cb.ft. at 60° F. and 30 in. barometric pressure.

During the war circumstances arose which fully justified, as a temporary measure, the relaxation of some of the conditions formerly imposed upon British gas undertakings, which were permitted to supply gas of much lower calorific value and higher water-gas content than in pre-war days. In the circumstances this could not well be helped, and it was endured by consumers without complaint as a war necessity. Unfortunately, however, the gas industry, having thus been liberated temporarily from former controls and restrictions, yearned for a more permanent emancipation therefrom; and so what may be termed a strong "life and liberty" movement set in, more particularly in the direction of supplying gas of lower calorific value, on the plea of benefiting the consumer by giving him cheaper gas-therms than otherwise he could obtain.

At this point the Fuel Research Board stepped in, at the request of the Board of Trade, with the object of advising "what is the most suitable composition and quality of gas and the minimum pressure at which it should be generally supplied, having regard to the desirability of economy in the use of coal, the adequate recovery of by-products, and the purposes for which gas is now used." The answer of the Fuel Research Board to the prevailing view in the gas industry "that the elasticity in manufacture can best be secured by the fixing of a sufficiently low calorific standard" was somewhat vague and hesitating; but the Board rightly based its recommendations upon the principle that "the interests of the consumers can best be conserved if their contract with the gas undertaking is based on the sale and purchase of heat energy measured in fixed units which can be scientifically determined by simple means." And it was therefore proposed that "the consumer should be charged for the thermal units which he actually receives in the same way as the consumer of electricity is charged for the Board of Trade units which pass through his meter." This important conclusion was, however, accompanied by a pronouncement that "the natural diluent for coal-

gas is water-gas"; and the Board finally recommended that, subject to the foregoing principle, the gas undertakings should be "free to deliver to the consumer any mixture of the ordinary combustible gases free from sulphuretted hydrogen and not containing more than 12 per cent. of inert constituents," whilst suggesting "the standardisation of burners in appliances for a limited number of calorific values" between 400 and 500 B.Th.U. per cb.ft. The Board's main recommendations, except as regards inert constituents, were given effect to by the Gas Regulation Act of 1920, which also provided (*inter alia*) that the Board of Trade shall, as soon as may be after the passing of this Act, cause an inquiry to be held into the question whether it is necessary or desirable to prescribe any limitations of the proportion of carbon monoxide which may be supplied in gas used for domestic purposes.

Now, whilst it is generally admitted that there are certain economic advantages to be gained by supplying the public with coal-gas diluted with water-gas, there are, nevertheless, weighty objections to an *unlimited* proportion of the latter being allowed in a domestic gas supply, arising from the poisonous nature of carbon monoxide (of which water-gas contains about 42 per cent., as against, say, 7 per cent. in coal-gas), and also from the fact that the range of explosibility of water-gas–air mixtures is considerably wider than that of coal-gas–air mixtures. Any *large* admixture of water-gas with coal-gas in a domestic supply would add materially to the dangers both of carbon monoxide poisoning and of gas explosions in houses.

The dangers of carbon monoxide poisoning with gas containing a large proportion of water-gas formed the subject of an official inquiry by a Committee (of which Dr. J. S. Haldane and the late Sir William Ramsay were members) appointed by the Home Office, whose Report (Cmd. 9164) was issued in the year 1899. This Committee considered that the most probable manner in which accidental death from gas poisoning would occur would be from gas, inhaled during sleep, escaping from a burner left full on unlighted; and, influenced by experiments made by Dr. Haldane, as well as by detailed information laid before them as to the uses of water-gas in the United States and its effect upon human health, and having in mind also the nature of carbonic oxide poisoning and the faulty character of gas pipes and fittings in the poorer class of house, the Committee reported that "the most direct, and in our opinion, the only effective method of preventing danger from water-gas is to fix a limit which the carbonic oxide in a public and domestic gas supply shall not, in ordinary circumstances, exceed." And, whilst admitting the difficulty of assigning a limit applicable in all circumstances, they suggested that 12 per cent. of carbonic oxide would in ordinary circumstances be a proper limit, with 20 per cent. as the highest that should ever be allowed, and that "only under special circumstances." Since this Committee reported there has probably been some (though not a great) improvement in the character of the gas service-pipes and fittings in the poorer class of houses. Also the more extended use of incandescent mantle lighting has undoubtedly meant that less gas (in the ratio of, say, 7 to 10) would nowadays escape into a bedroom, from a burner left full on unlighted, than twenty years ago. Therefore, if in 1899 somewhere between 12 and 16 per cent. of carbonic oxide was considered to be, "in ordinary circumstances," a proper limit, it would follow (the poisonous nature of carbonic oxide remaining unchanged) that to-day 20 per cent. might similarly be considered a reasonable maximum limit. This last-mentioned view was taken by the British Association Fuel Economy Committee in its Second and Third Reports (1919 and 1920), and afterwards supported, on physiological grounds, by Dr. J. S. Haldane in his evidence before the Board of Trade Committee. The adoption of such a limit would mean that the gas undertakings would be at liberty to supply a mixture of one hundred parts of straight coal-gas with (up to) fifty parts of blue water-gas, a fairly generous allowance of the last-named.

But the gas industry is to-day much more strongly organised and entrenched than it was twenty years ago. So, whilst admitting that few undertakings would be inconvenienced by a limit of 20 per cent. of carbonic oxide, except in cases of emergency, and disclaiming any present intention of supplying very high percentages of water-gas (in London a proportion of only $33\frac{1}{3}$ per cent. of carburetted water-gas being contemplated), its advocates argued before the Board of Trade Committee that the advantages of cheaper gas (although nowadays gas, at twelve to fifteen pence per therm, seems a very dear fuel) outweigh the danger to human life feared from higher proportions of carbon monoxide, and, therefore, that no statutory limitation should be imposed. Eventually, as the result of its inquiry, the Committee did so decide, being "greatly impressed by

the necessity of allowing the development of the gas industry to proceed, without any check on its natural progress."

Such was the Committee's conclusion on the matter, but it was qualified by the suggestion "that the Departments concerned should carefully watch the situation so that, if the freedom from limitation which we recommend is accompanied by unexpectedly unfavourable results, the attention of Parliament may, if necessary, be again directed to the matter," as though the Committee had still some misgivings about its verdict and did not consider it as final. Certainly, in the light of statistics relating to accidental gas poisoning placed before the Committee by the Registrar-General's Department, and those published for the years 1914–19 by the Gas and Electric Light Commissioner of Massachusetts, which are referred to in the Report, there would appear to be a much greater risk of accidental death from carbon monoxide poisoning in localities where coal-gas largely diluted with water-gas is supplied than in those in which no water-gas is added. Indeed, it seems arguable that, had the matter been decided mainly by such statistics, and on the physiological evidence, rather than on those of the cheaper production of gas, a verdict in favour of limitation would have been the more natural and appropriate one.

There is admittedly much to be said on hygienic grounds in support of the argument for cheaper gas, especially in view of the great improvements made during recent years in gas fires, and their consequent wider adoption for the heating of living rooms which are in use for part of the day only. For such purposes, as well as for cooking, gas is still an economical fuel, not so much on grounds of its initial cheapness (for it is a relatively dear fuel as compared with coal), as on those of convenience and cleanliness. It may, however, be argued perhaps with even greater force that, for the ordinary living rooms of a house, which require to be heated all day long, there is probably nothing more healthy and economical than radiation from red hot semi-carbonised coke burning in an open fireplace, and that it is in such direction, rather than that of gas heating, that the ultimate solution of the domestic smoke nuisance mainly lies, although undoubtedly each method will contribute to the desired end.

The Committee does not appear to have considered at all the question of the greater risks of back-firing and explosions arising out of the much wider range of explosibility of coal-gas when largely diluted with water-gas for a domestic supply, although this is a matter of some importance. Moreover, it seems to have been overlooked that whereas the gas supply of many American cities may contain as much as 25 to 30 per cent. of carbon monoxide, yet it would be of a much higher calorific standard (*vide* that of New York) than any gas supplied, or likely to be supplied, under the new regulation by British undertakings. Indeed, it is a matter of mere arithmetic that an American burner supplied with gas of 675 B.Th.U. per cb. ft., and containing 27 per cent. of carbon monoxide, would, for a given heat development in the flame, actually pass somewhat less carbon monoxide in a given time than a British burner supplied with a 475 B.Th.U. gas containing only 20 per cent. of carbon monoxide. It may, however, be hoped that British gas undertakings will, in their own interests, voluntarily work within such a 20 per cent. limit, and that gas consumers generally will fully realise the importance of keeping a sharp look-out for gas leakages and of using only the best-made taps and fittings.

W. A. B.

Diseases of the Rubber Tree (Hevea braziliensis).

The Diseases and Pests of the Rubber Tree. By T. Petch. Pp. x+278+6 plates. (London: Macmillan and Co., Ltd., 1921.) 20s. net.

THE growth of the rubber plantation business, in which many millions sterling of British capital are invested, provides a striking example of the advantages that accrue from the combination of science and industry. It is, indeed, not too much to say that but for this combination the rubber planting industry, as it has flourished during the last ten years or more, could scarcely have maintained its existence.

It is not necessary to direct attention to the essential aid which science has given in enabling the raw rubber to be fitted for its various commercial applications. On the other hand, the present extensive development of rubber in industry would not have been possible had not scientific help been at hand to enable the plantations themselves to be maintained. In the earlier days, as in many another tropical agricultural industry, all went very well with the planter—and then came the inevitable onset of disease, which under tropical conditions of growth may, and if unchecked will, easily assume serious proportions. The first serious check in the history of the plantation enterprise came in the form of a root

disease, due to the effects of a species of Fomes (*F. lignosus*). The life history of the disease was worked out, its source and the conditions of attack became known through scientific investigation, and then rational methods of control were devised.

Some optimists thought that thenceforth all serious trouble was at an end, but experience has confirmed the views of those who at that time expressed a contrary opinion. There are now known to be a number of pests, mostly fungal, which threaten more or less dangerously the existence of the rubber trees. It is not unlikely that others will appear in the future, which either have not yet gained access to the plantations or perhaps have not yet acquired their full virulence. At any rate it may be stated confidently that the maintenance of scientific investigation, which alone can provide the essential conditions for the control of disease, is a prudent measure that is of vital importance to the existence of the whole industry.

It is fortunate that the men who control largely the development of the great rubber plantations appreciate fully the services which science can render, and actually has rendered in the past, and this circumstance is one of the best guarantees of the future success of the enterprise.

Naturally, a considerable mass of knowledge has accumulated on the causes and methods of treatment of the various diseases to which the rubber trees are known to be liable, and it is fortunate that Dr. Petch, with his long experience in Ceylon, should have set himself the task of presenting, in a readily available form, the results of that experience in the book under notice. By the term "tree" is meant, of course, the Para rubber tree, *Hevea braziliensis*, which from the planter's point of view is the only rubber-producing plant of importance. Dr. Petch discusses the subject partly from the general point of view, and shows how neglect of correct principles of cultivation may promote disaster. He then describes the characters presented by the various parasites, and their several effects on the rubber tree itself, indicating, or at least discussing, the remedial or preventive measures which should be adopted. Excellent plates are given in the body of the work illustrative of the various diseases, and we could have wished it had been possible to print an explanatory legend at the foot of each plate, to avoid having to turn elsewhere in the text for identification of the figures; perhaps this may be possible in a future edition.

The book is much more than a mere guide to the pests, animal and vegetable, that afflict Hevea. Its pages abound in acute observations and suggestions that make it valuable from the point of view of general pathology, and render it of interest to a wider circle of readers than the rubber planters for whom it was primarily written. The author also hints at the preparation of a companion volume that shall deal with the subject from a more physiological point of view. The need for such a work is pressing, for quite apart from the more general aspects of pathology which may be expected to fall within the scope of such a volume, the whole question of the function of the complex latex and the problems of predisposition to disease have never yet received adequate treatment. For the present we conclude by congratulating the author on the production of a real contribution to the literature of economic botany, and the publishers also deserve commendation for the excellent form in which the subject-matter and the illustrations are presented to the reader. J. B. F.

Some Psychological "As Ifs."

(1) *Psychology and Mystical Experience.* By Prof. John Howley. Pp. xi+275. (London: Kegan Paul, Trench, Trubner and Co., Ltd.; St. Louis, Mo.: B. Herder Book Company, 1920.) 10*s.* 6*d.* net.

(2) *The Science of Ourselves.* (*A Sequel to the "Descent of Man."*) By Sir Bampfylde Fuller. (Oxford Medical Publications.) Pp. ix+326+2 plates. (London: Henry Frowde; Hodder and Stoughton, 1921.) 16*s.* net.

(3) *Religion and the New Psychology.* By W. S. Swisher. Pp. xv+261. (London: George Routledge and Sons, Ltd., n.d.) 10*s.* 6*d.* net.

(4) *Collected Papers on the Psychology of Phantasy.* By Dr. Constance E. Long. Pp. xii+216. (London: Baillière, Tindall, and Cox, 1920.) 10*s.* 6*d.* net.

(1) PROF. HOWLEY'S study is a sound piece of work written by one who has knowledge and training along lines of thought which we cannot afford lightly to dismiss. Without denying the validity of the concept of sub-consciousness (in some sense of the word) he rejects that of merely automatic combination of psychic elements therein. "We must," he says, "posit some agency other than the psychic elements considered in themselves." Mystic experience is a direct realisation, *sine intermedio*, by the agent of the Agent beyond. What the author speaks of as "agnostic psychology" may try to interpret this in terms of illusion; but how comes it that the illusion conduces to useful and sustained effort?

(2) Sir Bampfylde Fuller builds a super-

structure of thought-process, interpreted with some originality in the light of long experience in affairs, on a frankly materialistic foundation. Mind *is* (and not only is in some way correlated with) physiological process in the brain. The development of the cerebral hemispheres "introduces a new and peculiar nervous condition—that of consciousness." "Ideas are material things, and may be figured as clusters of brain-cells."

(3) Mr. Swisher gives us his solution of "*the* religious problem"—*i.e.* "the perfect adjustment of the ego to its environment—the immediate environment and the cosmos." To him the gospel of Freud carries glad conviction. When we grasp adequately the nature of the unconscious through the methods of psycho-analysis we shall realise its influence on the religious life. The conclusions to which the author has been led are set forth with much vigour and freshness, and if he is satisfied "that religion had a phallic origin" he has full right to say so. The chapter on mysticism and neurotic states invites comparison with Prof. Howley's more "academic" treatment based on convictions derived from an older gospel.

(4) Dr. Constance E. Long founds her doctrine rather on the fourth gospel of Jung than on the second gospel of Freud, though both must be included in the canonical books of the new faith. A candid friend, who is an academic psychologist, bade her—as she tells us in the preface—alter her title, saying that the book has nothing to do with psychology. She retained it, however, "because the book deals with an aspect of phantasy to which academic psychology is paying considerable attention at present." At the same time she warns her readers that they will find in it nothing about such matters as "the relation of imagination to perception." One would have thought that the discussion throughout turns very largely on the nature of this relation. At all events, whatever label others may see fit to affix to him, no psychologist can afford to disregard new facts in whatever manner they may be reached, and Dr. Constance Long adduces many facts which are worthy of careful consideration.

Huxley was wont to warn us against passing too lightly from "as if" to "is," pointing the moral in one of his class lectures by reference to Darwin's twenty years' testing of natural selection. He did not disparage the value of hypothesis; his meaning was that we should differentiate the several values of our hypothetical "as ifs," and lay bare the evidence which marks the difference in probability between the 0·95 which approaches the, perhaps unattainable, 1 of "is," and the 0·05 which is all that sundry flimsy conjectures can legitimately claim. It looks as if the integration which obtains in human fantasy and thought were due to an integrating agency other than the natural relatedness of the psychic elements considered in themselves. It is for Prof. Howley to assign the probability-value of this "as if" and to marshal the evidence in its favour. To Sir Bampfylde Fuller it looks as if thought were *in pari materia* with cerebral organisation; it is for him to state the probability-coefficient of this hypothesis and produce evidence in support of its approximation to 1. It looks as if there were imaginal complexes in that which seems as if it were a psyche nowise dependent for its existence on the structure and function of the brain; it is for Dr. Constance Long and Mr. Swisher to justify their existential "is" in the unconscious.

An "as if" accepted as "is" becomes a basal assumption or presupposition from which flows the "must be" so obvious to the acceptor that demand for evidence on the part of the critic seems unreasonable. Memory-images as such "must be" retained somewhere; if not in consciousness, and if not in the brain, then obviously in the unconscious. Retention otherwise than as such—*i.e.* retention of the conditions under which fresh blossoms of imagery shall appear under appropriate excitation—is left out of consideration; but should it not be considered and the ground of rejection laid bare? Retention of memory-images as such in the unconscious seems to be the cardinal "as if" of much psycho-analysis; but is it wholly unreasonable to ask for evidence?

To put the matter more concretely, suppose that someone has a dream in which there are certain imaginal factors in fantasy—say, *k, m, o*. On a later occasion, by the method of "free association," other factors—say, *j, l, n, p*—are *then* rendered supra-liminal. What is the probability-value of the inference that they were subliminally present *as imaginal factors latent on the prior occasion of the dream?* There is here no question of familiarity with the facts. We may grant that as facts they are given correctly. It is a matter of evidence for or against an "as if" on the basis of which the facts are interpreted.

C. LL. M.

Our Bookshelf.

Penrose's Annual. Vol. 24 of *The Process Year Book and Review of the Graphic Arts*, 1922. Edited by W. Gamble. Pp. xii + 91 + plates. (London: Lund, Humphries, and Co., Ltd., 1921.) 8*s.* net.

ALTHOUGH the editor has nothing particularly new to bring forward this year, he has succeeded in

making a very interesting and instructive volume. We think that the illustrations, which are many and various, reach a rather higher standard of excellence than that to which we have been accustomed. The editor tells us that undoubtedly, in time, all text-composing for printing will be done by a photo-mechanical process, and that this matter is still being worked at and progress made. Collotype, which many used to suppose to be too troublesome to work in this country, because of the vagaries of the climate, appears to be gaining in favour, and can be combined with offset methods to considerable advantage. An example of such a combination is given in a coloured collotype of Messrs. Howard and Jones. The history of the Print Society by Mr. M. F. Whittington, with offset examples, will be appreciated by many artists and collectors who favour etching as a means of expression. Mr. Gamble, in his "Review," refers to the neglect of inventors and inventions, and we would heartily second his desire that such neglect might be avoided. He is, however, unfortunate in one of his examples —namely, the "Electrical Inkless Printing" process, which was shown some five-and-twenty years ago by the late Mr. Friese Greene. Mr. Gamble says that Mr. Greene "was unable to find the necessary financial support, and the process died out of recollection." The weak point of that method was diagnosed in a moment by those who were well grounded in scientific principles. The paper was sensitised all over (essentially by a salt of manganese), but the sensitive material unused was not, and probably could not be economically, removed. The present writer has specimens that were then produced. For years they have been covered with a dirty brown stain, often in smudges, and the staining has extended to the envelope that contains them.

C. J.

Vorlesungen über die Theorie der Wärmestrahlung. By Prof. Max Planck. *Vierte, Abermals Umgearbeitete Auflage.* Pp. xi+224. (Leipzig: Johann Ambrosius Barth, 1921.) 36 marks.

THIS work has now gone through four editions, and it remains the standard book on the theory of radiation. The earlier parts, dealing with the classical theory, are practically unaltered, and constitute still far the most thorough introduction which a student could have into the rather difficult ideas of the theory. The later part differs from the earlier editions very considerably. In the first and second editions the end of the book contained a good deal of rather arid discussion of the radiation problem from several only slightly different points of view. All this has now been replaced by a very interesting development of the quantum theory, in particular of those branches, including radiation, which concern temperature problems. The discussion from the point of view of entropy is very complete, except for the lack of an explanation of why it is right first to define entropy in terms of probability, and then to re-define probability—the so-called thermodynamic probability—so as to derive from it the "absolute" entropy. Apart from this question of the arbitrary constant in the entropy, there is a very clear account of Planck's more recent work on the equation of state of gases.

Der Entropologische Gottesbeweis: Die physikalische Entwicklung des Entropieprinzips, seine philosophische und apologetische Bedeutung. By Dr. Josef Schnippenkötter. Pp. 109. (Bonn: A. Marcus and E. Webers Verlag, 1920.) 15 marks.

To anyone familiar with modern physics it is a frequent occurrence to observe encroachments of the second law of thermodynamics on more and yet more branches of science; but it comes at first as rather a surprise that it covers a still wider field and has also an application in theology. Yet the connection is not so remote as appears at first sight, for alone of all the laws of Nature the second law deals with non-conservative processes. According to a certain school of thought the laws of dynamics and electro-dynamics, being conservative, might be left to run themselves, but the degeneration of energy can only be taken to prove that the world must have been started at some time and must end at some future date—hence the title. The author of this philosophical work has evidently read widely in the literature of the philosophy of science and in science itself. There are discussions of 320 papers in it; indeed, almost every page is covered with references. He draws the cautious conclusion that entropy does not necessarily imply the existence of the Deity.

A Text-book of Qualitative Analysis of Inorganic Substances. By Dr. S. A. Kay. Pp. vii+80. (London: Gurney and Jackson; Edinburgh: Oliver and Boyd, 1921.) 7*s.* 6*d.* net.

THE practical details of analysis are described in this book more minutely than is customary in order to minimise the necessity of constant supervision of the student. All accounts of the theory, even the chemical equations of the reactions, are omitted. These are to be discussed orally. It would, however, have been very much better to have included them, since students usually carry out the tests mechanically unless they have their attention constantly directed to the chemistry involved. The result is rather reminiscent of cookery.

Geography for Junior Classes. By E. Marsden and T. A. Smith. Pp. viii+278. (London: Macmillan and Co., Ltd., 1920.) 5*s.*

THE book under notice is suggestive of the bad old geography furbished and brought up to date. The last three parts cover the British Empire, and a general view of the continents. The first is mainly pure physics of a brand which is not welcome. The phrase "Lines and Belts of Equal Heat" is bad anywhere, but much worse in a head-line. The book will not help to improve school geography.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Tendency of Elongated Bodies to Set in the East and West Direction.

PERHAPS readers of NATURE will recognise the principle of the Eötvös torsion balance in the communication of Sir Arthur Schuster published in NATURE of October 20 (p. 240) entitled "The Tendency of Elongated Bodies to Set in the North and South Direction." The calculation there given is, however, incomplete, and this causes the sign of the effect to be reversed. For the hypothetical "normal case" a complete calculation shows that the tendency is rather for an elongated body to set itself in an east and west direction. The missing element in the calculation is the difference in the directions of the centrifugal force on the different portions of the rod. If we call λ the longitude, reckoned from the meridian of the centre of the rod, of an element ds of the rod at distance s from the centre, then approximately $\lambda = s \sin\phi / a \sin\theta$, where a is the radius of the earth and the remaining notation is the same as in the original communication. Since λ is small, we may write for the horizontal force perpendicular to the meridian of the centre of the rod $\sigma\rho\omega^2\lambda ds$; its moment is $(\sigma\rho\omega^2\lambda ds)(s\cos\phi)$, or, finally, since $\rho = a\sin\theta$, the moment of an element of length ds is

$$\sigma\omega^2 s^2 \sin\phi\cos\phi\, ds.$$

It is easily seen that the horizontal component of the centrifugal force is always directed outward from the central meridian, and therefore tends to bring the rod into the prime vertical. The above expression combines with the moment given in the original communication, namely, $\sigma\omega^2 s^2 \cos^2\theta \sin\phi\cos\phi\, ds$ (after correcting an obvious typographical error), giving

$$\sigma\omega^2 s^2 \sin^2\theta \sin\phi\cos\phi\, ds.$$

By integration along the rod we get for the entire turning moment

$$I\omega^2 \sin^2\theta \sin\phi\cos\phi,$$

where I denotes the moment of inertia, as in the original communication.

As a matter of fact, we must consider not only the effect of the change in direction and amount of the centrifugal force, but also the changes in gravity due to the departure of the earth from a spherical form. We have, in effect, treated the earth as a spheroid having an ellipticity due only to the direct effect of the centrifugal force—that is, an ellipticity of $\omega^2 a/2g$, where g is the acceleration of gravity. We may get the complete expression by writing instead of $\omega^2 a/2g$ the actual ellipticity of the earth, e. (This is not offered as a proof.) The result is

$$(2egI/a) \sin^2\theta \sin\phi\cos\phi.$$

In an article of mine published in the September issue of the *American Journal of Science*, and briefly noticed in NATURE for October 6 (p. 192), I have described the Eötvös balance from a different point of view, and have shown how the rod may be thought of as falling while turning about its axis of suspension, because, owing to the different curvatures of the different vertical planes, it actually diminishes its potential energy in turning. The prime vertical is the vertical plane of minimum curvature in the normal case, and it is towards this vertical plane that the body tends to turn.

Now experiments with the Eötvös balance have shown that the actual condition at any particular point is generally very far from normal, so much so that it is quite conceivable that at the place of Mr. Reeves's experiment the tendency should be more nearly towards the meridian than towards the prime vertical.

The body tends to set itself in the vertical plane of minimum curvature, wherever that may be, and if we reckon the angle from this plane the moment of the force acting is numerically

$$gI(1/R - 1/N) \sin\phi\cos\phi,$$

where R and N are the minimum and maximum radii of curvature of the level surfaces of the earth's gravity field at the point of observation. For the "normal case" this expression readily reduces to the one already given. Observations with the Eötvös balance enable us to determine for any point the value of $1/R - 1/N$ for the level surface passing through the centre of the rod and the directions of the principal planes of curvature of the level surface. There is also a second type of Eötvös balance in which a mass at one end of the rod is balanced by a weight suspended from the other by a fibre of some length.

To illustrate the erratic nature of the curvatures of the level surfaces near the surface of the earth when these are studied in detail, I take from the work of Prof. Soler ("Prima Campagna con la bilancia di Eötvös nei dintorni di Padova," Venice: Reale Commissione Geodetica Italiana, 1914) the following values of the angle β, which is the angle between the meridian and the direction in which gravity is increasing most rapidly. The normal value of β is zero. The actual values at a number of successive stations, all near Padua, were found to be 189°, 147°, 282°, 306°, 274°, 33°, and 304°. The balance used here was of the second type.

Although the curvature of any level surface near the earth is very irregular in detail, it is fairly regular on the average. That is, we may consider the level surface as made by superposing on a fairly smooth surface a number of undulations, short and sharp, but of small amplitude. The Eötvös balance picks up mainly the curvatures of the sharp undulations, while in ordinary geodetic work we get only a sort of average curvature of the surface on which the undulations are superposed.

WALTER D. LAMBERT.
U.S. Coast and Geodetic Survey,
Washington, D.C., November 21.

Japanese Culture Pearls.

A NOTICE has recently appeared in the daily Press, signed by a number of jewellers, with reference to Japanese "culture" pearls. This notice, besides endorsing the opinion expressed by the diamond, pearl, and precious stones section of the London Chamber of Commerce that "the insertion of foreign matter placed in the oyster" disqualifies the culture pearl from competing with the pearl produced without the aid of man, declares that "cultured" pearls can be distinguished from Indian pearls.

The first of the above statements was justly ridiculed at the time it was made by Sir Arthur Shipley in a letter to the *Times* (May 7, 1921), and is not likely to be taken seriously by the more intelligent members of the pearl-purchasing public.

The second statement is, however, sufficiently inexact to be liable to mislead the public. The only established difference between the culture pearls now on the market and "Indian" pearls, a difference revealed by their different fluorescence under ultra-violet light, is one that holds good also for "naturally produced" pearls from the Japanese pearl oyster, and is due to minute differences in the optical properties of the nacre of the Persian Gulf and Japanese oysters. An attempt is thus made to depreciate culture pearls by confusing them with naturally pro-

duced Japanese pearls, while the fact that culture pearls produced in other localities, or in other species or races of pearl oysters, will probably be indistinguishable from naturally produced pearls from the same sources is not mentioned.

It is a significant fact that the English pearl merchants and jewellers have apparently made no attempt to obtain and publish scientific opinions on the problems raised by the coming of the "culture pearl." This will probably prove in the end a shortsighted policy. It is quite likely that the values of the stocks of "natural" pearls which are held by merchants and others will suffer very much more from the uncertainty and confusion which are created by statements like those referred to here than they would have suffered from a full and frank explanation to the public of the exact nature, and probable future development, of the Japanese discovery. This discovery, important as it is as a scientific achievement, need not have produced the panic which, to judge from their behaviour, seems to prevail in certain sections of the precious stones trade. If at the outset the merchants and jewellers had acted as realists instead of behaving (and thinking they could induce the public to behave) in the manner so often wrongly attributed to the ostrich, it is quite likely that the pearl market would by this time have adjusted itself to the change.

H. LYSTER JAMESON.

A Curious Physiological Phenomenon.

AT a recent meeting of biologists at Strasbourg Messrs. A. Schwartz and P. Meyer directed attention to the curious physiological phenomenon which is shown by the following experiment:—

With arms hanging relaxed, stand about 18 in. from any solid structure, such as a wall, and face the direction parallel to the wall. Stiffen the arm next the wall and move it away from the body until the back of the hand comes into contact with the wall; stand firm and press the wall as hard as possible with the back of the hand for about 15 seconds. Now relax the arm, step away from the wall, and this is what will happen:

To the observer's astonishment, his arm will slowly rise, without his making any voluntary effort, until it reaches an approximately horizontal position; it will remain there for a few seconds and then fall back. Whilst the phenomenon is taking place the observer has the sensation that his arm is raised by an exterior force which is quite independent of volition. Anyone interested in the explanatory theories put forward by the above-mentioned gentlemen should consult the *Comptes rendus de la Société de Biologie*, vol. 85, No. 27, July 23, 1921, p. 490.

F. C. DANNATT.

198 Rue Saint-Jacques, Paris (5e), November 28.

I FIRST came across this phenomenon in 1917, when it was shown as a "parlour trick" in an officers' mess in Macedonia. It is obviously of the greatest interest, but I was unable to trace it to its origin.

To the description in Mr. Dannatt's letter may be added the observation that the movement ensues even where the subject has no knowledge of what is about to occur—my first personal experience of the phenomenon occurred before I was told what to expect. This is of importance, for it removes possibility of "suggestion." The phenomenon is a physiological one.

Any explanation at present must be purely hypothetical. The "voluntary" movement of a limb is brought about through the activity of the "motor" area pyramidal cells in the cortex of the great brain. Such reactions (under experimental conditions) are often followed by the opposite form of movement—*e.g.* flexion by extension (Graham Brown and Sherrington, Proc. Roy. Soc., B, vol. 85, p. 250, 1912). But the peculiarity of the present movement is that it is in the same direction as the original one. That is, the upper limb is pressed against the wall in a voluntary manner; after a few seconds' rest it is raised towards the wall in an involuntary manner. After-discharge of the same movement may, however, also occur under experimental conditions (called "tonus remainder" by the above investigators). But this involuntary movement of the arm occurs after a distinct pause.

The curious lack of "volition" whilst the arm is rising might be explained (on the assumption that the movement is due to an after-discharge of the motor cortical area) if the feeling of voluntary fatigue depends upon functional changes a step back in the cerebral path. Thus the motor cells are set into activity by other nerve cells. If the fatigue of volition occurs in these other cells, and the after-discharge in the motor cells themselves, the absence of a feeling of "voluntary effort" might be explained.

The movement—the slow, involuntary rise of the arm—is, however, not like those obtained from the motor area of the great brain when it is stimulated. But it *is* like the movements obtained from another motor mechanism—that of the "red nucleus" and other structures in the mid-brain and hind brain. I think that the phenomenon is far more likely one brought about by this other motor system, which is essentially concerned in the slow "postural" movements and maintained postures of the body (Graham Brown, Proc. Roy. Soc., B, vol. 87, p. 145, 1913). It is more than likely that the two motor mechanisms combine in directing muscular activities—sometimes reinforcing one another, sometimes inhibiting. If this is the case, the pressing of the arm against the wall may be brought about by both mechanisms, the drop of the arm at the end of the voluntary act may be an additional voluntary act, and the after-discharge of the "red nuclear" mechanism (to give it a too restricted name) may later reassert itself. *Or* the "motor area" activity may from the first inhibit the "red nuclear," and when the former is "fatigued" the latter may assert itself in a "rebound" from its state of inhibition.

Enough has been said to indicate our ignorance of the conditions which might explain the phenomenon and to show how speculative any explanation must be at present. One last suggestion may be made. The phenomenon may be related to the curious maladjustment of movement which occurs after a heavy weight has been carried for a distance and then abandoned. Everyone who has carried a heavy knapsack for a distance and then laid it down knows how his first few steps without it are unbalanced.

T. GRAHAM BROWN.

Physiology Institute, University College, Cardiff, December 8.

Echinoderm Larvæ and their Bearing on Classification.

IN NATURE of December 8 there appears an article by my friend Dr. F. A. Bather entitled "Echinoderm Larvæ and their Bearing on Classification." The article consists of a review of Dr. Mortensen's work entitled "Studies of the Development and Larval Forms of Echinoderms," and in the course of the article Dr. Bather quotes with apparent approval some remarks of Dr. Mortensen to which I desire to take the strongest exception.

First, Dr. Bather quotes an observation of Dr. Mortensen's in which he describes the larva of an Ophiurid dropping the young brittle-star and then proceeding to regenerate itself, and states that this observation suggests that the metamorphosis of Echinoderms is an alternation of generations. I can only say that this observation of Dr. Mortensen stands in urgent need of confirmation, and that it is totally opposed to what we know of the normal development of Ophiurids. In the development of *Ophiothrix fragilis* the adult takes over from the larva the mouth, œsophagus, stomach, intestine, peritoneal sacs, and aboral integument, and what is left of the larva after this abstraction is merely the ciliated band, the larval organ of locomotion. This development is no more an alternation of generations than is the development of the veliger into the adult mollusc. The same type of metamorphosis is found in the pelagic larvæ of Holothuroids and Echinoids; in Asteroids the only additional feature to be observed is the shrivelling and disappearance of the præoral lobe which acts as stalk during the earlier stages of metamorphosis. Secondly, Dr. Bather states that Dr. Mortensen has shown that the Brachiolaria stage in Asteroid development (in which the larva uses its præoral lobe as a stalk) cannot be homologous with the similar stage of development in Crinoids, since it is found only amongst the "more specialised forms of Asteroids."

No more rash statement could be made nor one more devoid of foundation. Modern Asteroids are divided into five groups, viz. Forcipulata, Valvata, Velata, Paxillosa, and Spinulosa. Nothing whatever is known of the development of any valvate and velate form, but the fixed stage is found not only in the development of the Forcipulata (which Dr. Mortensen arbitrarily regards as the most specialised forms), but also in the development of the Spinulosa (which all admit to be the most primitive group). In the Paxillosa, which include the British genera Astropecten and Luidia, and which, *mirabile dictu*, Dr. Mortensen appears to regard as primitive forms, the fixed stage is omitted; the larva apparently amputates its præoral lobe and does not use it as a stalk.

The Paxillosa, so far from being primitive, are quite a modern development of Asteroid structure in the Ophiuroid direction. They have in most cases lost the anus and in all cases the sucking discs of the tube feet, and they have developed a quite un-Asteroid mobility and muscularity of the arms. Luidia even snaps off the arms on irritation exactly like an Ophiuroid.

The reason why the fixed stage is omitted in their development is not far to seek. What we know of their habits points to their being inhabitants of the sand and mud. Such a habitat is utterly unsuitable for the support of a fixed stage, and consequently this stage has been omitted in their life-history.

When, however, we reflect that the Echinoderms are admitted by all to be descended from the same stock, that this stock must have passed through a fixed stage, since primitive Crinoids are fixed, and that the stalks of Crinoids and Asteroids are formed from the same region of the larva, we shall be in a position to estimate the value of Dr. Mortensen's views. His ideas of the ancestry of Echinoderms would carry more weight if he had worked out with thoroughness the complete life-history of any Echinoderm.

Lastly, I should like to protest against the idea that those interested in Echinoderms agree with the overestimate of the importance of trifling peculiarities in the structure of pedicellariæ in which Dr. Mortensen indulges. As Dr. Bather says, they are of no use to the palæontologist, and Dr. Bather, who is not only a systematist, but also a first-class morphologist, will realise that Dr. Mortensen's views are accepted by few except himself.

E. W. MACBRIDE.

Royal College of Science, South Kensington, London, S.W.7, December 14.

PROF. MACBRIDE has allowed his enthusiasm for the truth, as he sees it, to blind his eyes to what I actually did say. I said the idea of alternation of generations, though recalled by Dr. Mortensen's account of an observation, was "not really justified." I also characterised Dr. Mortensen's own inference from that observation as "audacious." I am glad to find that Prof. MacBride agrees with me, even if his mode of expressing agreement be unusual.

I did not say that Dr. Mortensen had "shown" (which I take to mean "proved") those statements and conclusions concerning the Brachiolaria and its sucking disc to which Prof. MacBride takes exception. By using the expression "none the less" I meant to imply that his conclusion on this point was not on all-fours with his general conclusion. Prof. MacBride differs from me in the vigour with which he rubs in that argument. I am glad that my remark has aroused so doughty a champion to the defence of the Brachiolaria, but I confess that I am not as yet prepared to broider any published classification of the Asteroidea on my own banner.

It is not for me to break any lances in defence of Dr. Mortensen, but if Prof. MacBride is acquainted with Dr. Mortensen's "Studies in the Development of Crinoids" (see NATURE, vol. 107, p. 132, March 31, 1921) I am rather astonished that he should so belittle our Danish colleague's work on those lines. As for the importance that Dr. Mortensen attaches to pedicellariæ, I incline to think that it is his critics who "overestimate" it. He himself has written (1907, "Ingolf Exped., Echinoidea," vol. 2, p. 12):—"I have never stated that the classification has always to be based on the pedicellariæ as the most important factor; on the contrary, I am of opinion that where structural characters of some significance occur in the test, these are, upon the whole, of higher classificatory value than the characters in the pedicellariæ."

Prof. MacBride is as friendly and complimentary to me as he always is, even when we differ, but, however much he may differ from Dr. Mortensen, I do hope he realises that the latter has furnished us in this memoir with a number of novel observations obtained with labour and recorded with skill.

F. A. BATHER.

Some Problems in Evolution.

THE address of Prof. Goodrich on "Some Problems in Evolution," which I read in NATURE of November 24, incidentally deals in a slight but somewhat dogmatic manner with the question, "What share has the mind taken in evolution?" I do not propose myself to attempt to answer this question, but only to point out that the grounds on which Prof. Goodrich deals with the matter are quite inconsistent with well-established phenomena which are familiar to psychologists and psychotherapists.

Prof. Goodrich says, "I would maintain that there is no justification for the belief that it (mind) has acted, or could act, as something guiding or interfering with the course of metabolism." He scouts the idea "of the influence of the mind on the activities of the body," and says, "we cannot conceive how a physical process can be interrupted or supplemented by non-physical agencies." He tells us that the student of biology "should realise that the mental series of events lies outside the sphere of natural science," and relegates such matters to the realm of *philosophy*.

I have no doubt that Prof. Goodrich is familiar with recent advances in psychotherapy, and I cannot imagine how he reconciles them with the above statements. The treatise on "Suggestion and Autosuggestion," by Prof. Badouin, which describes the practice of the new Nancy school, gives plenty of examples of curative processes, which necessarily involve metabolism, set in motion by purely mental processes. A good example is furnished by the article of Prof. J. Stanley Gardiner in NATURE of December 15, p. 505. If autosuggestion can initiate metabolism in the individual, why is it to be ruled out as a possible factor in evolution? Prof. Goodrich is not an advocate of the view that only congenital characteristics can affect the progeny of the individual. If the requisite "environmental stimulus" persists I gather that in his opinion an acquired modification may also persist. In this connection it is surely a loss to his theory to rule out the effect which environment may produce primarily on the mind, and through the mind on metabolic processes. Why is the student of biology to regard all this as "outside the sphere of natural science"?

W. R. BOUSFIELD.

IN answer to Mr. W. R. Bousfield's question I may say that he is mistaken if he thinks that I would deny the possibility of curative processes being set going by "suggestion." But I would maintain that suggestion is not a mental process. There is a popular error, widespread, that thought can be directly transferred, whereas, as a matter of fact, we know that one organism communicates with another by physical means through the organs of sense—by touch, smell, taste, sight, and hearing. Suggestion consists in bringing to bear appropriate stimuli which directly or indirectly set going certain metabolic processes; or, to put it in another way, the stimuli excite in the organism responses which from one aspect appear as a series of metabolic processes, and from another aspect as a series of mental processes. The one series cannot be altered without also altering the other.

IN NATURE of November 17 Dr. J. T. Cunningham complains that I have ignored "the greater part of all the new conceptions and new results obtained by recent research on heredity and genetics." Now it is difficult within the limits of a short address to guard against all possible misunderstanding, yet I think Dr. Cunningham might have gathered that my object was to concentrate on certain fundamental problems, avoiding all unnecessary detail. Although yielding to none in my admiration for the triumphs of Mendelism, I purposely set aside (as stated in a footnote) complications due to hybridisation, the formation of heterozygotes, segregation, etc., because they did not seem to me to bear directly on the questions discussed. My innocent statement "that the newest characters may be inherited as constantly as the most ancient, provided they are possessed by both parents," in no way contradicts Dr. Cunningham's own statement "that a character may be inherited when it is apparent only in one parent or in neither," a fact which, by the way, was known before Mendelism was invented. I still hope that nothing said in the address is inconsistent with even the newest sound conceptions and newest results of experimental genetics.

In the third paragraph of his letter, while seeming to agree that a change of character must be due either to an alteration of the germinal factors or of the environmental conditions, Dr. Cunningham confuses the issue by failing to distinguish consistently between the variation and the resulting character. This is just one of the important distinctions which, as I endeavoured to show in the address, must be realised if we are not to waste time in endless and futile controversy.

Great as is our debt to Weismann, it must be acknowledged that not a little of the confusion in discussions on "acquired characters" is traceable to obscurities and inconsistencies in his writings. In this matter I gladly acknowledge my indebtedness to the works of Sir Archdall Reid. No one, I think, has so clearly shown that, as some others saw before him, there are two kinds of variation, but only one kind of character.

E. S. GOODRICH.

Oxford, December 9.

World List of Scientific Periodicals.

THE Conjoint Board of Scientific Societies proposes, if sufficient support is obtained, to arrange for the issue of a world list of periodical publications which contain the results of original scientific research, and has entrusted preliminary arrangements to a committee, of which the following are members:—Sir Sidney F. Harmer (chairman), Mr. F. W. Clifford, Sir Richard Gregory, Dr. P. Chalmers Mitchell, Mr. A. W. Pollard, and Prof. W. W. Watts, secretary.

The list will be an octavo volume containing, in alphabetical order, the titles and places of publication of all such periodicals in existence on January 1, 1900, and of all issued after that date.

Libraries in London, Oxford, Cambridge, Edinburgh, Dublin, and Aberystwyth which take in these periodicals will be indicated in the list, and, wherever possible, at least one library in the United Kingdom will be indicated for each title.

The copies will be printed on one side only to facilitate alterations and additions.

The objects of the proposed volume are: (1) To supply as nearly as possible a complete list of current scientific periodicals; (2) to indicate, where possible, at least one library where each periodical is taken; (3) to form a basis for co-operation between libraries, so that both the number of duplicates and the list of periodicals not taken in may be reduced; and (4) to enable each library to use the list for its own purposes, by placing a mark against the title of each periodical it possesses, by cutting up for a card index, etc.

The trustees of the British Museum, recognising the importance of this work to scientific research and bibliography, have consented to allow the compilation to be undertaken by the staff of the Museum. They are unable, however, to defray the cost of printing and publication.

Although the value of a list of this kind to libraries and scientific societies would be very great, it is scarcely possible that the production of so costly a work would be entertained by a publishing firm as an ordinary commercial enterprise. If, however, a sufficient number of libraries and institutions agree in advance to purchase one or more copies, when issued, the compilation of the list will be put in hand at once. Already a large bulk of material has been collected in the British Museum by various societies and by the Conjoint Board.

I shall be glad to receive by January 31, if possible, the names and addresses of institutions or individuals who will support this proposal by undertaking to subscribe for one or more copies of the list. The price per copy will be 2*l.* 2*s.* net.

W. W. WATTS.

Conjoint Board of Scientific Societies,
Burlington House, London, W.1.

Old Observations Bearing on the Duration of Sunrise.

IN 1769 the French academician Le Gentil went on a journey to Mauritius, Pondichéry, and Manila to

observe the transit of Venus and to study atmospheric refraction in the tropics. As an incident of the latter, while at Pondichéry he observed carefully the form of the rising sun, with attendant phenomena, and noted the instants of upper and lower contacts in several cases, with the help of the telescope of his quadrant and a clock. While he does not seem to have made any further use of the durations deducible from his observations, nevertheless with the help of the *Nautical Almanac* of that year and a standard astronomical formula one may compute the duration which would have held on the assumption of constant refraction, and may compare this with the actual observations and with the accompanying descriptions of the sun's form. The subjoined table shows the results. Type A (see *Popular Astronomy*, "On Types of Sunrise and Sunset," vol. 29, p. 251, 1921; NATURE, October 13, p. 211), which is a mirage type, has an average excess of +2·3 per cent. as compared with computation; the one type B case has an excess of +5·3 per cent. These results agree with numerous observations made by the present writer at various stations in Pacific and Atlantic waters. It is as if the sun sets behind a receding horizon and rises beyond an approaching horizon.

Local date, 1769	Duration Obs.	Duration Comp.	Dif.	Per cent.	Type
	m s	m s	s		
I 7 A	148·5	144·6	+3·9	+2·8	A
I 9 A	147·4	144·4	+3·0	+2·1	A
I 10 A	145·0	144·1	+0·9	+0·6	A
II 1 A	145·4	139·7	+5·7	+4·1	A
VI 18 A	148·4	140·9	+7·5	+5·3	B

WILLARD J. FISHER.

The Measurement of Ionisation Currents by Three-electrode Valves.

IN view of the advantages offered by the use of valves for measuring ionisation currents, which have been pointed out in a recent paper by M. J. Malassez (*Comptes rendus*, vol. 172, p. 1093, 1921), it appears to be of some interest to describe another method of using valves for this purpose, differing in its application from that adopted by M. Malassez.

The method described by M. Malassez gives directly the mean ionisation during a certain interval of time by determining the time required to discharge a condenser from 40 volts to a small potential indicated sharply by the valve. It is intended to measure ionisation currents, of the order of 10^{-8} amperes, produced by X-rays when conditions are such that the leakage through the valve can be neglected.

In the method to be described the ionisation is measured by the steady deflection of a galvanometer. It permits changes of ionisation within short intervals of time to be followed, and can readily be adapted to a balance method.

The arrangement is given by the accompanying sketch (Fig. 1).

The plates of the valves V_1, V_2 are connected through equal resistances r_1, r_2. One terminal of each of these resistances is connected to the positive pole of the battery, the other terminals are connected through the galvanometer g. The resistances R_1, R_2 regulate the heating currents through the filaments. Each grid can be connected to the positive plate of an ionisation chamber through the leads C_1 or C_2.

The heating currents are set so as to give equal plate currents through both valves when the grids are insulated. When, owing to the action of the ionisation current, one of the grids receives a charge, the plate current through the corresponding valve is altered and the galvanometer is deflected. An ionisation current acting on the other filament causes a galvanometer deflection in the opposite direction.

The sensitiveness is, in general, different for ionisation currents acting on each of the grids, but for each one the deflections of the galvanometer are fairly proportional to the ionisation currents. If required, inequalities in the valves can be corrected by interposing an E.M.F. in one of the valve circuits by means of a battery and suitable resistances.

When two valves are used in this way, fluctuations in the heating currents and in the plate potentials are reduced owing to the fact that the heating currents for the filaments and the plate voltage are supplied from the same sources for both valves.

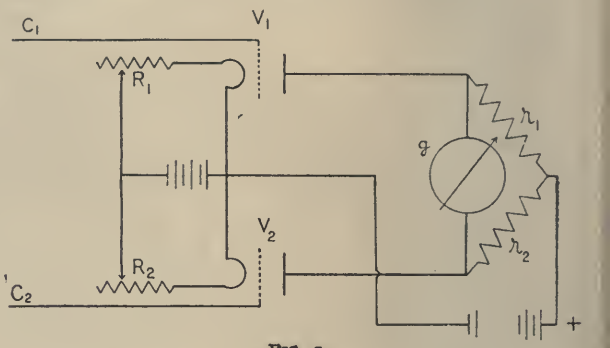

FIG. 1.

A fuller discussion of the method and more details of the experiments carried out will be given elsewhere.

When some radio-active deposit emitting α-rays is gradually brought near to an ionisation chamber of suitable shape it is easy to show the amount of ionisation for different distances (Bragg's curve) by the deflections of a unipivot galvanometer. When a more sensitive galvanometer is substituted for the unipivot instrument, in a set of observations the sensitivity for current was 3×10^{-13} amperes with a sensitivity for voltage of $1{\cdot}2 \times 10^{-4}$ volts, although the valves used were rather soft and not suitable for high current sensitivity, and no amplification device was used.

J. C. M. BRENTANO.

Manchester University, Manchester, December 10.

Simple Sensitive Flames.

IT does not seem to be well known that it is quite easy to make a very simple flame sensitive to sounds of short wave-length for working with gas at ordinary supply pressure.

Such a sensitive jet is obtained from a glass tube, of diameter about 1 cm., simply by rotating the end of the tube in a blow-pipe flame, so that it takes the shape of a dome with an orifice. This shape provides the sudden change of pressure on which sensitiveness depends. While the glass is still soft it is slightly flattened so as to make the orifice noticeably elliptical. As with high-pressure jets, the flame loses sensitiveness if the orifice be too nearly circular, or if its ellipticity be too great. The best condition is attained by trial. If the orifice be too large the flame is easily disturbed by draughts or by slight variations in the pressure of the gas. If it be too small the normal gas pressure is too low to give a flame on the point of flaring, a well-known condition of sensitiveness. These low-pressure flames are sensitive to lower pitched sounds than is usual with high-pressure flames. Like the latter, they are most sensitive to sounds in a particular direction, viz., the direction of the major axis of the elliptical orifice.

G. A. SUTHERLAND.

University College, W.C.1, December 6.

The Message of Science.[1]

By Sir Richard Gregory.

IT is just forty years ago, at the York Meeting in 1881, that a committee was appointed "to arrange for a conference of delegates from scientific societies to be held at the annual meetings of the British Association, with a view to promote the interests of the societies represented by inducing them to undertake definite systematic work on a uniform plan." The Association had been in existence for fifty years before it thus became a bond of union between local scientific societies in order to secure united action with regard to common interests. Throughout the whole period of ninety years it has been concerned with the advancement and diffusion of natural knowledge and its applications. The addresses and papers read before the various sections have dealt with new observations and developments of scientific interest or practical value; and, as in scientific and technical societies generally, questions of professional status and emolument have rarely been discussed. The port of science—whether pure or applied—is free, and a modest yawl can find a berth in it as readily as a splendid merchantman, provided that it has a cargo to discharge. Neither the turmoil of war nor the welter of social unrest has prevented explorers of uncharted seas from crossing the bar and bringing their argosies to the quayside, where fruits and seeds, rich ores and precious stones have been piled in profusion for the creation of wealth, the comforts of life, or the purpose of death, according as they are selected and used.

All that these pioneers of science have asked for is for vessels to be chartered to enable them to make voyages of discovery to unknown lands. Many have been private adventurers, and few have shared in the riches they have brought into port. Corporations and Governments are now eager to provide ships which will bring them profitable freights, and to pay bounties to the crews, but this service is dominated by the commercial spirit which expects immediate returns for investments, and mariners who enter it are no longer free to sail in any direction they please or to enter whatever creek attracts them. The purpose is to secure something of direct profit or use, and not that of discovery alone, by which the greatest advances of science have hitherto been achieved.

To the man of science discoveries signify extensions of the field of work, and he usually leaves their exploitation to prospectors who follow him. His motives are intellectual advancement, and not the production of something from which financial gain may be secured. For generations he has worked in faith purely for the love of knowledge, and has enriched mankind with the fruits of his labours; but this altruistic attribute is undergoing a change. Scientific workers are beginning to ask what the community owes to them, and what use has been made of the talents entrusted to it. They have created stores of wealth beyond the dreams of avarice, and of power unlimited, and these resources have been used to convert beautiful countrysides into grimy centres of industrialism, and to construct weapons of death of such diabolical character that civilised man ought to hang his head in shame at their use.

Mankind has, indeed, proved itself unworthy of the gifts which science has placed at its disposal, with the result that squalid surroundings and squandered life are the characteristics of modern Western civilisation, instead of social conditions and ethical ideals superior to those of any other epoch. Responsibility for this does not lie with scientific discoverers, but with statesmen and democracy. Like the gifts of God, those of science can be made either a blessing or a curse, to glorify the human race or to destroy it; and upon civilised man himself rests the decision as to the course to follow. With science as an ally, and the citadels of ignorance and self as the objective, he can transform the world, but if he neglects the guidance which knowledge can give, and prefers to be led by the phrases of rhetoricians, this planet will become a place of dust and ashes.

Unsatisfactory social conditions are not a necessary consequence of the advance of science, but of incapacity to use it rightly. Whatever may be said of captains of industry or princes of commerce, scientific men themselves cannot be accused of amassing riches at the expense of labour, or of having neglected to put into force the laws of healthy social life. Power—financial and political—has been in the hands of people who know nothing of science, not even that of man himself, and it is they who should be arraigned at the bar of public justice for their failure to use for the welfare of all the scientific knowledge offered to all. Science should dissociate itself entirely from those who have thus abused its favours, and not permit the public to believe it is the emblem of all that is gross and material and destructive in modern civilisation. There was a time when intelligent working men idealised science; now they mostly regard it with distrust or are unmoved by its aims, believing it to be part of a soul-destroying economic system. The obligation is upon men of science to restore the former feeling by removing their academic robes and entering into social movements as citizens whose motives are above suspicion and whose knowledge is at the service of the community for the promotion of the greatest good. The public mind has yet to understand that science is the pituitary body of the social organism, and without it there can be no healthy growth in modern life, mentally or physically.

This conference of delegates provides the most

[1] Abridged from the presidential address delivered to the Conference of Delegates of Corresponding Societies of the British Association at Edinburgh on September 8.

appropriate platform of all those offered by the British Association from which a message of exhortation may be given. There are now 130 corresponding societies of the Association, with a total membership of about 52,000, and their representatives should every year go back not only strong with zeal for new knowledge, but also as ministers filled with the sense of duty to inspire others to trust in it. In mechanics work is not considered to be done until the point of application of the force is moved; and knowledge, like energy, is of no practical value unless it is dynamic. The scientific society which shuts itself up in a house where a favoured few can contemplate its intellectual riches is no better than a group of misers in its relations to the community around it. The time has come for a crusade which will plant the flag of scientific truth in a bold position in every province of the modern world. If you believe in the cause of disciplined reason you will respond to the call and help to lift civilised man out of the morass in which he is now struggling, and set him on sound ground with his face toward the light.

It is not by discoveries alone, and the records of them in volumes rarely consulted, that science is advanced, but by the diffusion of knowledge and the direction of men's minds and actions through it. In these democratic days no one accepts as a working social ideal Aristotle's view of a small and highly cultivated aristocracy pursuing the arts and sciences in secluded groves and maintained by manual workers excluded from citizenship. Artisans to-day have quite as much leisure as members of professional classes, and science can assist in encouraging the worthy employment of it. This end can be attained by co-operative action between local scientific societies and representative organisations of labour. There should be close association and a common fellowship, and no suggestion of superior philosophers descending from the clouds to dispense gifts to plebeian assemblies. It should also always be remembered that a cause must have a soul as well as a body. The function of a mission-hall is different from that of a cinema-house or other place of entertainment, and manifestations of the spirit of science are more uplifting than the most instructive descriptive lectures.

Science needs champions and advocates in addition to actual makers of new knowledge and exponents of it. There are now more workers in scientific fields than at any other time, yet relatively less is done to create enthusiasm for their labour and regard for its results than was accomplished fifty years ago. Every social or religious movement passes through like stages, from that of fervent belief to formal ritual. In science specialisation is essential for progress, but the price which has to be paid for it is loss of contact with the general body of knowledge. Concentration upon any particular subject tends to make people indifferent to the aims and work of others; for, while high magnifying powers enable minute details to be discerned, the field of vision is correspondingly narrowed, and the relation of the structure as a whole to pulsating life around it is unperceived.

As successful research is now necessarily limited for the most part to complex ideas and intricate details requiring special knowledge to comprehend them, very special aptitude is required to present it in such a way as will awaken the interest of people familiar only with the vocabulary of everyday life. In the scientific world the way to distinction is discovery, and not exposition, and rarely are the two faculties combined. Most investigators are so closely absorbed in their researches that they are indifferent as to whether people in general know anything of the results or not. But where one person will exercise his intelligence to understand the description of a new natural fact or principle a thousand are ready to admire the high purpose of a scientific quest and reverence the disinterested service rendered by it to humanity. The record of discovery or description of progress is, therefore, only one function of a local scientific society; beyond this is the duty of using the light of science to reveal the dangers of ignorance in high as well as in low places. Though in most societies there is only a small nucleus of working members, the others are capable of being interested in results achieved, and a few may be so stimulated by them as to become just and worthy knights of science, ready to remove any dragons which stand in the way of human progress, and continually upholding the virtues of their mistress.

Every local scientific society should be a training ground for these Sir Galahads, and an outpost of the empire of knowledge. The community should look to it for protection from dangers within and without the settlement, and for assistance in pressing further forward into the surrounding woods of obscurity. At present it is unusual for this civic responsibility to be accepted by a scientific society, with the result that local movements are undertaken without the guidance necessary to make them successful. A local scientific society should be the natural body for the civic authority to consult before any action is taken in which scientific knowledge will be of service. It should be to the city or county in which it is situated what the Royal Society is to the State, and not a thing apart from public life and affairs.

When wisdom is justified of her children, and local scientific societies are no longer esoteric circles, but effective groups of enlightened citizens of all classes, they will provide the touchstone by which fact is distinguished from assertion and promise from performance. As the sun draws into our system all substantial bodies which come within its sphere of influence, while the pressure of sunlight drives away the fine dust which would tend to obscure one body from another, so a local scientific society possesses the power of attracting within itself all people of weight in the region around it and of dispersing the mist and fog which commonly prevail in the social atmo-

sphere. Thus may the forces of modern civilisation, moral and material, be brought together, and an allied plan of campaign be instituted against the armies of ignorance and sloth. The service is that of truth, the discipline that of scientific investigation, and the unifying aim human well-being. Kingsley long ago expressed the democratic basis upon which this fellowship is founded; and when he delivered his message artisans were crowding in thousands in Manchester and other populous places to lectures by leaders in the scientific world of that time. Labour then welcomed science as its ally in the struggle for civil rights and spiritual liberty. That battle has been fought and won, and subjects in bitter dispute fifty years ago now repose in the limbo of forgotten things.

There is no longer a conflict between religion and science, and labour can assert its claims in the market-place or council house without fear of repression. Science is likewise free to pursue its own researches and apply its own principles and methods within the realm of observable phenomena, and it does not desire to usurp the functions of faith in sacred dogmas to be perpetually retained and infallibly declared. The Royal Society of London was founded for the extension of *natural* knowledge in contra-distinction to the *supernatural*, and it is content to leave other philosophers to describe the world beyond the domain of observation and experiment. When, however, phenomena belonging to the natural world are made subjects of supernatural revelation or uncritical inquiry, science has the right to present an attitude of suspicion towards them. Its only interest in mysteries is to discover the natural meaning of them. It does not need messages from the spirit world to acquire a few elementary facts relating to the stellar universe, and it must ask for resistless evidence before observations contrary to all natural law are accepted as scientific truth. If there are circumstances in which matter may be divested of the property of mass, fairies may be photographed, lucky charms may determine physical events, magnetic people disturb compass needles, and so on, by all means let them be investigated, but the burden of proof is upon those who believe in them and every witness will be challenged at the bar of scientific opinion.

We do not want to go back to the days when absolute credulity was inculcated as a virtue and doubt punished as a crime. It is easy to find in works of uncritical observers of medieval times most circumstantial accounts of all kinds of astonishing manifestations, but we are not compelled to accept the records as scientifically accurate and to provide natural explanations of them. We need not doubt the sincerity of the observer even when we decline to accept his testimony as scientific truth. The maxim that "seeing is believing" may be sound enough doctrine for the majority of people, but it is insufficient as a principle of scientific inquiry. For thousands of years it led men to believe that the earth was the centre of the universe, with the sun and other celestial bodies circling round it, and controlling the destiny of man, yet what seemed obvious was shown by Copernicus to be untrue. This was the beginning of the liberation of human life and intellect from the maze of puerile description and philosophic conception. Careful observation and crucial experiment later took the place of personal assertion and showed that events in Nature are determined by permanent law and are not subject to haphazard changes by supernatural agencies. When this position was gained by science, belief in astrology, necromancy, and sorcery of every kind began to decline, and men learned that they were masters of their own destinies. The late war is responsible for a recrudescence of these medieval superstitions, but if natural science is true to the principles by which it has advanced it will continue to bring to bear upon them the piercing light by which civilised man was freed from their baleful consequences.

There is abundant need for the use of the intellectual enlightenment which science can supply to counteract the ever-present tendency of humanity to revert to primitive ideas. Fifty years of compulsory education are but a moment in the history of man's development, and their influence is as nothing in comparison with instincts derived from our early ancestors and traditions of more recent times grafted upon them. So little is known of science that to most people old women's tales or the unsupported words of a casual onlooker are as credible as the statements and conclusions of the most careful observers. Where exact knowledge exists, however, to place opinion by the side of fact is to blow a bubble into a flame. Within its own domain science is concerned not with belief—except as a subject of inquiry—but with evidence. It claims the right to test all things in order to be able to hold fast to that which is good. It declines to accept popular beliefs as to thunderbolts; living frogs and toads embedded in blocks of coal or other hard rock without an opening, though the rock was formed millions of years ago and all fossils found in it are crushed as flat as paper; the inheritance of microbic diseases; the production of rain by explosions when the air is far removed from its saturation point; the influence of the moon on the weather or of underground water upon a twig held by a dowser, and dozens of like fallacies, solely because when weighed in the balance they have been found wanting in scientific truth. Its only interest in mysteries is that of inquiring into them and finding a natural reason for them. Mystery is thus not destroyed by knowledge but removed to a higher plane.

Never let it be acknowledged that science destroys imagination, for the reverse is the truth. "The Gods are dead," said W. E. Henley,

> "the world, a world of prose,
> Full-crammed with facts, in science swathed and sheeted,
> Nods in a stertorous after-dinner doze!
> Plangent and sad, in every wind that blows
> Who will may hear the sorry words repeated:—
> 'The gods are dead.'"

It is true that the old idols of wood and stone are gone, but far nobler conceptions have taken their place. The universe no longer consists of a few thousand lamps lit nightly by angel torches, but millions of suns moving in the infinite azure, into which the mind of man is continually penetrating further. Astronomy shows that realms of celestial light exist where darkness was supposed to prevail, while scientific imagination enables obscure stars to be found which can never be brought within the sense of human vision, the invisible lattice work of crystals to be discerned, and the movements of constituent particles of atoms to be determined as accurately as those of planets around the sun. The greatest advances of science are made by the disciplined use of imagination; but in this field the picture conceived is always presented to Nature for approval or rejection, and her decision upon it is final. In contemporary art, literature, and drama imagination may be dead, but not in science, which can provide hundreds of arresting ideas awaiting beautiful expression by pen and pencil. It has been said that the purpose of poetry is not truth, but pleasure; yet, even if this definition be accepted, we submit that insight into the mysteries of Nature should exalt, rather than repress, the poetic spirit, and be used to enrich verse, as it was by some of the world's greatest poets—Lucretius, Dante, Milton, Goethe, Tennyson, and Browning. With one or two brilliant exceptions, popular writers of the present day are completely oblivious to the knowledge gained by scientific study, and unmoved by the message which science is alone able to give. Unbounded riches have been placed before them, yet they continue to rake the muck-heap of animal passions and stir the froth of sloppy sentiment for themes of composition. Not by their works shall we become "children of light," but by the indomitable spirit of man ever straining upwards to reach the stars.

Where there is ignorance of natural laws all physical phenomena are referred to supernatural causes. Disease is accepted as Divine punishment to be met by prayer and fasting, or the act of a secret enemy in communion with evil spirits. Because of these beliefs thousands of innocent people were formerly burnt and tortured as witches and sorcerers, while many thousands more paid in devastating pestilences the penalty which Nature inevitably exacts for crimes against her. In one sense it may be said that the human race gets the diseases it deserves; but the sins are those of ignorance and neglect of physical laws rather than against spiritual ordinances. Plague is not now explained by supposed iniquities of the Jews or conjunctions of particular planets, but by the presence of an organism conveyed by fleas from rats; malaria and yellow fever are conquered by destroying the breeding places of mosquitoes; typhus fever by getting rid of lice; typhoid by cleanliness; tuberculosis by improved housing; and most other diseases by following the teachings of science concerning them. Though the mind does undoubtedly influence the resistance of the body to invasion by microbes, it cannot create the specific organism of any disease, and the responsibility of showing how to keep such germs under control, and prevent, therefore, the poverty and distress due to them, is a scientific rather than a spiritual duty.

The methods of science are pursued whenever observations are made critically, recorded faithfully, and tested rigidly, with the object of using conclusions based upon them as stepping-stones to further progress. They demand an impartial attitude towards evidence and fearless judgment upon it. These are the principles by which the foundations of science have been laid, and a noble structure of natural knowledge erected upon them. A scientific inquiry is understood to be one undertaken solely with the view of arriving at the truth, and this disinterested motive will always command public confidence. It is poles apart from the spirit in which social and political subjects are discussed: it is the rock against which waves of emotion and storms of rhetoric lash themselves in vain. If political science were guided by the same methods it would present an open mind to all sides of a question, weighing objections to proposals as justly as reasons in support of them, whereas usually it sees only the views of a particular class or party, and cannot be trusted, therefore, to strike a judicial balance. The methods of science should be the methods applied to social problems if sound principles of progress are to be determined. When they are so used a statesman will be judged, as a scientific man is judged, by correct observation, just inference, and verified prediction; in their absence politics will remain stranded on the shifting sands of barter, concession, and expediency.

Local scientific societies should provide a common forum where workers with hand or brain can meet to consider new ideas and discuss judicially the significance of scientific discovery or applied device in relation to human progress. At present such societies are mostly out of touch with these practical aspects of knowledge, and are more interested in prehistoric pottery than in the living world around them. Most of those connected with the British Association are concerned with natural history, but all scientific societies in a district should form a federation to proclaim the message of knowledge from the house-tops. Men are ready to listen to the gospel of science and to believe in its power and its guidance, but its disciples disregard the appeal and are content to let others minister to the throbbing human heart. Civilisation awaits the lead which science can give in the name of wisdom and truth and unprejudiced inquiry into all things visible and invisible, but the missionary spirit which would make men eager to declare this noble message to the world has yet to be created.

This is as true of the British Association itself as it is of local scientific societies. It seems to

be forgotten that one of the functions of the Association is to inspire belief and confidence in science as the chief formative factor of modern life, and not only to display discoveries or enable specialists to discuss technical advances in segregated sections. Though members of the Association may be able to live on scientific bread alone, most of the community in any place of meeting need something more spiritual to awaken in them the admiration and belief which beget confidence and hope. They ask for a trumpet-call which will unite the forces of natural and social science, and are unmoved by the parade of trophies of scientific conquests displayed to them. It was the primary purpose of Canon W. V. Harcourt, the chief founder of this Association and its general secretary from 1831 to 1837, to sound this note for "the stimulation of interest in science at the various places of meeting, and through it the provision of funds for carrying on research," and not for "the discussion of scientific subjects in the sections." In the course of time these sectional discussions have taken a prominent place in the Association's programme, and rightly so, for they have promoted the advancement of science in many directions; but, while we recognise their value to scientific workers, we plead for something more for the great mass of people outside the section-rooms, for a statement of ideals and of service, of the strength of knowledge and of responsibility for its use. These are the subjects which will quicken the pulse of the community and convert those who hate and fear science and associate it solely with debasing aspects of modern civilisation into fervent disciples of a new social faith upon which a lever made in the workshops of natural knowledge may be placed to move the world.

Integration in the Living Organism.

By PROF. W. M. BAYLISS, F.R.S.

THE name "organism," given to the individual units of living matter as they are met with in Nature, implies that these act as unified and co-ordinated entities. At the same time, it must be remembered that an organism considered apart from its environment is merely a theoretical abstraction; but, apart from the way in which they react to external influences, there must be means by which the activity of any one part is adjusted to the needs of the whole, and the investigation of these various means may be said to form a large part of modern physiology. In a general sense, it may be looked upon as distinctive of the more recent outlook, for most of us are not content with ascribing the mutual co-ordination of function to a presiding directive agency, be it called "entelechy," "élan vital," or other mysterious influence. We want to know more of the actual chemical and physical methods at work in the process, and we believe that it is possible to find out a great deal more about them than we know as yet. The change in the point of view of the physiologist may be realised better if we call to mind that it is no longer thought scientific to devote attention to the "functions of the liver," for example, but to those processes, such as deamination and regulation of carbohydrate supply, in which this organ plays a part in combination with various other tissues of the organism. We ask: What part does the liver play in the correlated series of changes associated with the using up of the materials of the food for the supply of energy to, and for the growth of the cells of, the organism as a whole?

Broadly speaking, there are two great "systems"—to use a term which is rather antiquated in this sense—that serve as the means of communication between different parts of the higher animals—the nervous system and the vascular system. There are corresponding means of communicating by messages or by actual transport of materials in the higher plants. As a first approximation, we may call the former physical and the latter chemical. These correspond to the "nervous" and "humoral" factors of the French physiologists. The central nervous system, in addition to its obvious function of receiving impressions from the outer world and reacting upon it by reflexes to muscles, obtains messages from the various parts of the organism itself by means of appropriate receptors therein. Thus "effectors"—muscles, glands, etc.—are modified in their activity, and the special requirements of active organs are met. For example, an active secreting gland receives an increased supply of blood, containing sugar and oxygen, by dilatation of the blood vessels to it. By the blood, or similar circulating liquid, a chemical substance made in one place is carried over the whole of the organism, and in special places adjusted to be sensitive to it brings about appropriate reactions, which may affect a large number of other organs. Thus the carbon dioxide produced in active muscles reaches the respiratory nervous centre, exciting this to increase the ventilation of the lungs and supply more oxygen to the muscles by means of the blood.

The comparison of the nervous system to the telegraphic circuits of a city has often been made, and is probably more to the point than is sometimes thought, since there are many reasons for supposing that the passage of impulses along nerves is essentially of an electrical nature. The vascular system may similarly be compared to mechanical transport, by which coal, for instance, is conveyed in carts. In this latter case, material substances are sent from place to place. Perhaps a closer analogy to the blood vessels with their

pump, the heart, would be the distribution of water in pipes; but everyday experience reminds us that there is also a postal system by means of which actual material bodies convey *messages*. Thus a letter can order a supply of coal or cut off the electric current. The "chemical messengers" or "hormones" are the letters of the living organism. When the acid contents of the stomach pass into the intestine a chemical compound of unknown constitution is formed in the cells lining this tube, passes into the blood, and ultimately arrives at the pancreas, the cells of which alone of all those with which the blood comes into contact are able to respond to its stimulus. This they do by secreting pancreatic juice. The hormone, called "secretin," merely to give it a name, is a letter sent to the pancreas by the food asking for the enzymes needed to digest it. It does not serve in any sense as food for the cells, it is not a part of the secretion, but sets the machinery to work.

The fact must not be overlooked, however, that these various means of integration act together. Just as coal can be ordered by telegram, so a supply of sugar or oxygen can be ordered by a nervous message sent by an active organ, and we have already seen that a chemical messenger (=a letter) can excite the respiratory centre to send nervous impulses (=telegraphic messages) to the muscles producing respiratory movements. In general, co-ordination by chemical means is apt to be of a more prolonged or continuous nature than that by nervous reflexes. Even in the latter case, however, it is very common to find that an organ is under the continuous control of both excitatory and inhibitory nerves, the two opposing influences being in action at the same time. Any particular state is thus the expression of a preponderance on one or the other side of the balance. The fact has been made clear in the tone of the stomach of some reptiles, but it appears to be of wide occurrence, if not a general law.

The internal secretions of the endocrine glands are to be included in the category of chemical messengers. An interesting and instructive article by Prof. Strohl, of Zürich, was published in the *Revue générale des Sciences* (May 15, 1921), and, in point of fact, suggested the present remarks. His article deals with the general biological significance of the internal secretions, and contains a full list of papers, including those concerning lower animals. The author compares hormones to the electric waves of wireless telegraphy, since only certain tissues are tuned to respond to them. I venture to think that the postal system is a better illustration. Actual material bodies are carried, and these "letters" are accepted only at the correct addresses. In many cases, such as those of the suprarenal bodies and the thyroid gland, we are able to assign the function in question definitely to particular organs, which, indeed, appear to possess no other function.

In other cases, more difficulty is met with, owing to the fact that the cells producing the internal secretion are mixed up with cells having other known functions. Such, for example, is the case with the "islets of Langerhans," embedded in the pancreatic tissue which secretes the digestive juice. There is evidence that these "islets" produce a hormone which is required for the due utilisation of sugar. This co-existence, side by side, of cells with different functions is only one of the many difficulties met with in the study of internal secretions. It appears that removal of one particular endocrine organ affects the functions of those that are left. Indeed, the complexity of the phenomena may be some excuse for the contradictory and hazy statements so often made by workers on the problem, and for the hasty and sensational "discoveries" announced from time to time in the Press. This aspect of the subject is rightly emphasised by Gley in his valuable lectures on "Les Sécrétions Internes," where it is pointed out that clear and definite statements are much to be desired. Names are too often given which, although they profess to explain, are nothing but descriptions of the facts in other words. No advance is possible in this way.

The existence of certain organs or tissues which, so far as can be made out, have no function other than that of making chemical compounds for the purpose of acting on other tissues suggests the question whether those tissue cells which have obvious functions of another kind do not also give out to the blood substances which act in other places—whether the view of Brown-Séquard that all tissues make internal secretions may not be correct. In the simple case of carbon dioxide this is, of course, the case; but it is possible that many of the chemical products of the activity of cells may be inert for want of receptive cells sensitive to them. Many substances found in animals and plants appear to be waste products of metabolism—as, for example, the great variety of alkaloids met with in plants. There is evidence that some influence is exerted by cells on the growth and nature of cells of other kinds in their neighbourhood. The experiments of Champy may be cited as examples of this influence; moreover, fragments of differentiated tissue grown on a slide under the microscope are apt to lose their distinctive marks as they proliferate, and to become of an embryonic type. If, however, the fragment contains both epithelium and connective tissue, the new epithelial cells retain the characters of those from which they arise, so long as they remain in proximity to the connective tissue; but if they wander away they lose their identity and become generalised in aspect. Similarly, the excessive outgrowth of connective tissue in retinal fragments is held in check by the presence of nerve cells. It seems that the normal growth of tissue cells is only possible when under the "control" of other cells. This circumstance is significant in relation to the problem of malignant growths. Champy describes a

case of a particular tumour which was found on removal to be only in part malignant, but when a culture was made of the epithelium of the normal part the cells, deprived of the influence of their surrounding tissues, gave rise to daughter-cells similar to those of the malignant growth.

Again the power of survival of transplanted organs shows how complex is the variety of factors distinguishing one individual from another even within the same species. Prof. Leo Loeb has made a large number of experiments of this kind in the United States, and finds, in agreement with other workers, that tissues transplanted into another species die more or less rapidly; if put into another individual of the same species they also die in the end, but not so soon as in the first case. If simply moved into another part of the body of the same individual they survive and grow. In some cases they may survive in the body of an individual closely related to that from which the tissue was taken—as, for example, a brother. Now while Prof. Loeb assumes that the results are chiefly due to the giving off by the cells of specific chemical entities which differ from individual to individual, we must remember that we have no actual proof of this. It is perhaps well to be cautious until the specific properties are shown to be of a chemical nature. An interesting fact is that the specificity spoken of reaches this high state of development only in the higher vertebrates, and is much less manifest in their embryonic stages.

The hypothesis that all constituent cells of an organism give off internal secretions is clearly at the basis of hormone theories of heredity, such as that associated with the name of J. T. Cunningham. However inaccessible to influence of other kinds, it cannot be denied that the germ-plasm must be exposed to the action of substances in solution in the blood. The experiments of Stockard show that the germ-plasm in guinea-pigs is altered for several generations by the action of alcohol on the original parents. The removal of an organ, such as the tail, containing merely tissues abundantly present elsewhere would not be expected, on this hypothesis, to have any effect capable of hereditary transmission.

The internal secretions, especially those affecting growth, have an obvious resemblance to the accessory food factors or vitamins; but these have to be supplied to animals from the outside, ultimately from vegetable food, since plants only are able to make them. In neither case, however, do we know the chemical nature of the substance concerned. It may turn out that we have to do with minute traces of metallic elements, perhaps some of the rare metals. In that connection we are reminded of the necessity for zinc, in extremely small amounts, for the optimal growth of the mould Aspergillus. Certain of the endocrine organs may, indeed, have the function of supplying in an active or utilisable form some particular element, as appears to be the case with the thyroid gland in relation to iodine.

"Leader" Cables for Aircraft.

FOR some time past experiments have been in progress in adapting to the purposes of aerial navigation the "leader" cable system now successfully used in connection with shipping. Various tests made in this country revealed that a marine installation is of little use to aircraft, as no signals were received from the cable whilst an aeroplane was over the submerged part of it. But when the land portion of the cable was reached the signals it gave out were heard easily in the machine through an ordinary telephonic receiver. If the cable be laid above ground, or suspended from poles, the "leader" system can be employed as successfully to guide aircraft as to guide shipping. The principle is the same in each case, though some modifications in applying it are necessary.

So far as England is concerned, we do not appear to have gone much beyond demonstrating the fact that a "leader" cable for aircraft is a practical proposition. But Lieut. Loth, of the French navy, after devoting a considerable period to investigating the subject, has devised an aircraft "leader" cable which proved highly successful when tried at the Villacoublay aerodrome. This officer is well known for his work in connection with such cables, as he was largely responsible for laying the marine installation at Brest. His aerial apparatus follows closely upon the lines of that employed in ships. Three receiving coils are fixed on the aeroplane, and the pilot takes in signals by means of "listeners," or ear-pieces, in his helmet. When the machine is flying directly above, or parallel to, the cable a strong signal is transmitted to the pilot through the centre coil, and this continues so long as the cable is being "followed." The other coils indicate when the machine is to right or left of the cable, and enable the pilot to "pick up" the installation. Signals can be heard at an altitude of 10,000 ft. and for a mile and a half on either side of the cable.

In the case of a submarine cable, the area over which sound can be heard is necessarily limited, because a good deal of energy is expended in producing currents in sea water. In the air no such loss of energy occurs, and therefore the sound-range can be very materially increased. "Leader" cables fulfil the same function in relation to aircraft as to seacraft by enabling them to find their way home in thick weather or in the dark, and by adopting the system the practice of lighting flares on aerodromes is made unnecessary.

War Work of the Bureau of Standards, U.S.A.[1]

THE value of science to the belligerent countries was proved over and over again during the war—in the United States no less than in other countries. The United States, however, had the advantage over other countries in this as in other matters, that, before it joined in the fighting, many lessons had been learned or, at least, were in course of being learned, and of these by no means the least was the fact that scientific workers could render enormous service to the combatant forces. We find, therefore, that, from the very moment of America's entry into the war, the services of the Bureau of Standards were made use of in connection with the many problems which arose. The volume before us is a record of some of these activities, although, as is pointed out, some of the most interesting and important of the investigations carried out cannot be described owing to military or other reasons. Moreover, at the Bureau, as at our National Physical Laboratory, a great deal of the assistance rendered took the form of oral advice and consultations, the value of which cannot be estimated, and most of which was not of a nature to become part of the permanent records. In spite of these facts, so much work was carried out that the present volume is, perforce, little more than a series of brief abstracts of the many investigations undertaken, and it is possible in a review to pick out only a few of the more interesting of these and to refer briefly to them.

It is only natural that aeronautics should occupy a prominent place in the activities of the Bureau, and the report opens with a description of the work accomplished on aeronautical instruments. Many were designed at the Bureau, where provision was made to give thorough laboratory tests to 4 per cent. of the total production of the country. These tests included experiments carried out in temperature chambers and on vibration stands, so that the instruments might be subjected to the same conditions as would be encountered in actual use.

Of very great interest is the "altitude laboratory." This consists of a concrete chamber with walls capable of withstanding a considerable pressure from without. Within this chamber the engine under test is mounted and tested under varying conditions of temperature and pressure, it being possible to reduce the latter to as low as one-third of an atmosphere—corresponding to an altitude of 35,000 ft.

Exhaustive tests on ignition systems for aeroplane engines were also carried out, the majority on the sparking-plugs—or spark-plugs, as the Americans term them. The conditions to which these plugs are subjected in aero-engines are much more severe than in ordinary motor-car practice. The pressure inside the cylinders may amount to 600 lb. per square inch, and during operation the sparking-plug is exposed alternately to a blast of air which may be at a temperature well below zero, and to a flame of burning petrol, the temperature of which is estimated at 2500° C. As a result of research, several porcelains have been obtained, which have high electrical resistance and mechanical strength while hot, and are capable of withstanding sudden temperature changes; they have been largely used in the manufacture of sparking-plugs in the States. In addition to the work on the insulating material of the plugs, brittleness occurring in nickel electrodes has been investigated, and cements for fixing the electrode in the insulator have been studied.

A delightfully simple form of gauge for measuring the tension of aeroplane wires was designed at the Bureau. The wire is supported on two pins at a known distance apart, and loaded, by means of hand levers, at the middle of the span thus formed. The load is measured by means of one Ames dial, and the deflection of the wire by another. The dials are calibrated so that it is possible to read off the tension directly when the wire is deflected 0·1 in.

Reference must also be made to the work on dopes for aeroplane fabrics. These may be divided into two classes, cellulose nitrate dopes and cellulose acetate dopes. The former are highly inflammable, and therefore undesirable. Before the war America obtained all her cellulose acetate from the Bayer Company of Germany, and it was not until after seven months of war that provision was made for securing an adequate supply of raw material. In the meantime, the United States had been reduced to such devices as obtaining cuttings and scraps of kinema films in order to manufacture sufficient quantities of dope.

Leaving the aeronautical side of the report, and turning to the section headed "Gauges" (or rather "Gages"), one is impressed with the small amount of work done at the Bureau compared with what was done at the National Physical Laboratory. It appears that the total number of gauges tested at the Bureau and its branch laboratories was 60,000. This is about the average number tested in two months between 1915 and 1918 at the National Physical Laboratory, and about the average in six weeks during 1917–18.

Very interesting reading is furnished by the section on invisible signalling. In this connection a number of experiments were made, using both ultra-violet and infra-red radiations. It was found that the former were liable to fail owing to a fluorescence which was produced in the eye of the enemy observer—particularly if he were young. Infra-red rays, on the other hand, gave more promising results, but, as no methods are known for detecting them unless one is in the direct line of "sight," it is a moot question whether the method should be developed further.

It may seem a far cry from the study of ultra-

[1] "War Work of the Bureau of Standards." Pp. 299. (Washington: Government Printing Office.) 70 cents.

violet light for the purposes of invisible signalling to the investigation of sole leather for boots, but the report being arranged alphabetically, they come in close proximity therein. Perhaps this is well, for it indicates the widespread activities of the Bureau. Not only were the wearing properties of various soles, made of both leather and composition, tested, but a radiographic study of the clinching of the nails used in repairing the soles was also undertaken.

The work of the metallurgical department ranged between such widely different problems as the investigation of nails for horse-shoes and the study of gold-palladium alloys as substitutes for platinum. As is to be expected, the study of light (aluminium) alloys, largely in connection with aircraft requirements, occupies a prominent place. It is stated that the work to date has shown the superiority of alloys containing either copper and zinc or magnesium and copper as additions to aluminium, and it is of interest to note that the Bureau concentrated on magnesium-copper-aluminium alloys because the National Physical Laboratory was, at the time, investigating copper-zinc-aluminium alloys. In connection with these materials attention must be directed to the curious phrase referring to "the French alloy Duralumin," while later Wilm is correctly referred to as the discoverer of the hardening of this alloy after heat treatment.

Another use to which an aluminium alloy was put was for the manufacture of mirrors of high reflecting power, it being found that the compound Al_3Mg_4, containing 50 per cent. of magnesium, gave a reflection of 85 per cent. in the blue and 93 per cent. in the red portions of the spectrum, though such mirrors are not recommended where permanency is of prime importance. It may be of interest to note that the recent work of Hanson and Gayler, at the National Physical Laboratory, throws considerable doubt on the existence of this compound.

Amongst the many other metallurgical researches undertaken, two may be selected for mention; one is an investigation on the welding of steel, and the other a series of tests on different compositions of bearing metals.

The production and testing of optical glass are other branches of the activities of the Bureau which call for special mention. The manufacture was commenced in 1914–15—before America declared war—and in 1917 a large furnace holding a 1000-lb. pot was built, in which glass was produced on a commercial scale, and very satisfactory results were obtained.

Brief reference only can be made to other investigations described in the report. The photographic work, especially illustrating a view taken from an aeroplane through a haze, (1) on an ordinary plate, and (2) on a plate specially prepared at the Bureau, is of great interest. A very large amount of work on radio-communication, including special investigations on direction-finding and on signalling from submerged submarines, is also described. Investigations on rubber for tyres, insulated wire, etc., and work on sound-ranging and on sound transmitted through the earth, which was a development of British and French methods, also deserve mention. Work on textiles covers a very wide range of subjects, including some research on dye-stuff chemistry. Finally, there is the work on X-rays, which, however, was not initiated until 1917.

The Bureau of Standards is to be congratulated, not only on the immense amount of useful war work which it has carried out, but also on the interesting manner in which it has presented the summary of this work to the public.

J. L. H.

Obituary.

THE RIGHT HON. LORD LINDLEY, P.C., F.R.S.

THE name of the Right Hon. Lord Lindley, whose death, in his ninety-fourth year, occurred at East Carlton, Norwich, on December 9, will long be remembered as that of a distinguished lawyer and a great judge. The features in Lord Lindley's judgments which arrested attention were themselves due to the remarkable scientific instinct with which they were imbued. This quality may have been inherited, for the same independence and sagacity, displayed in another sphere, mark the writings of Lord Lindley's father, Dr. John Lindley, F.R.S., professor of botany at University College, and for many years the editor and principal proprietor of the *Gardeners' Chronicle*.

The constant intercourse between Prof. Lindley and Sir William Hooker, director of Kew during 1841–65, brought young Lindley into contact with Dr. (afterwards Sir Joseph) Hooker, assistant director of Kew from 1855, and Sir William's successor in the directorship during 1865–85. The fast friendship and constant correspondence thus initiated ended only with the death of Sir Joseph in 1911. This correspondence, it is fair to state, rarely related to technical botanical subjects. On the contrary, it indicates rather that Lindley and Hooker, who often consulted each other on important matters of business, each placed implicit reliance on the judgment of the other as to questions which concerned their own particular activities. But while it is doubtless true that the keen interest which Lord Lindley, throughout his long life, took in botanical pursuits was strengthened by his friendly relationship with Sir Joseph Hooker, it is unquestionable that it had its foundation in his admiration for, and sympathy with, his father's work. His interest led to intimate intercourse with other prominent contemporary botanists, notably with the late Mr. George Bentham, joint-author with Sir Joseph Hooker of that remarkable work, the "Genera Plantarum."

Equally keen throughout his life was the sym-

pathy displayed by Lord Lindley towards every effort to apply scientific methods in practical horticulture. This interest, too, is to be traced to his early admiration of the labours of his father in this field, though the continuance of that interest, in the midst of his professional and judicial preoccupations, may have been strengthened by the inheritance of Prof. Lindley's proprietary rights in the *Gardeners' Chronicle*. In the fortunes and the management of that important journal Lord Lindley was to the last keenly interested.

In recognition of the estimation in which his judicial eminence was held, the University of Oxford conferred on Lord Lindley the degree of D.C.L.; the Universities of Cambridge and Edinburgh both conferred on him that of LL.D. After he became a Lord Justice of Appeal his botanical friends, who were in a position to estimate his scientific as contrasted with his legal attainments, begged him to allow them to propose his name for election to the Royal Society. To this proposal Lindley declined to agree, on the ground that he was not a scientific worker and had no claim to be regarded as a patron of science. But the appointment of Lindley in 1897 to the Mastership of the Rolls gave the society an opportunity, which it took early in the following year, of electing him F.R.S. under a statute which at that time empowered them to do this in the case of any member of the Privy Council, so that this distinction, too, at least in form, was academic rather than scientific, though it was one worthily bestowed whether on academic or on scientific grounds.

We regret to announce the death on Saturday, December 17, of Dr. T. A. Chapman at the age of seventy-nine years. Dr. Chapman, who was the author of numerous papers on entomology and other branches of natural history, was elected a fellow of the Royal Society in 1918.

Notes.

Those interested in bibliographical research will be glad to learn that the proposals made in Nature of June last (vol. 107, p. 449) for the compilation of a Union List of Current Research Serials under the direction of the British Museum authorities have not fallen on barren ground. We trust that the appeal from the Conjoint Board of Scientific Societies, which appears in our correspondence columns, will meet with hearty and generous support from all copyright, State, and professional librarians, as well as from the larger rate-supported libraries. The action of the British Museum authorities in placing the services of their staff at the disposal of British science is specially noteworthy, and is of good augury for the future relations of literature and science. In one respect the scheme now submitted is an improvement upon our own, for the proposed list will include serials in existence on, or issued since, January 1, 1900. This will link up the list with those prefixed to the Subject Catalogues on Mathematics, Mechanics, and Physics for 1800–1900 published by the Royal Society. The existence of these lists should not be overlooked in the compilation of the present one. On the other hand, the proposal to include in the new list serials not available for reference in the United Kingdom may be thought of doubtful value and practicability. A Union List for Germany is already in existence, and a similar list for the United States is in preparation. The circulation of a list of these unrepresented periodicals through the research libraries should, however, bring about a wider selection in the future purchasing of periodicals. We trust that the most liberal interpretation will be placed upon the phrase "scientific periodicals," and that all departments of knowledge will be equally represented in respect of their research periodicals. On this and other points intending subscribers will no doubt be able to obtain further information, if desired, from the Conjoint Board.

The decision of the Electricity Commissioners on the schemes submitted to them in June and July last for re-organising the electricity supply in the London and Home Counties district was published last week. The Commissioners approve of the establishment of a joint authority on practically the same lines as those suggested by the London County Council, the local authorities owning electricity undertakings, and most of the principal supply companies. It will be remembered that the evolution of the scheme was to be in two stages. In the first stage, which ends at latest in 1926, about twenty-four of the existing generating stations were to be turned into sub-stations, receiving their energy in bulk from the remaining stations, which were to be linked together by interconnecting cables. This proposal receives the sanction of the Commissioners. In the second stage the original proposal was to shut down an additional twenty-six stations, leaving seventeen stations for generating the electrical energy. Two of these were to be capital stations, seven auxiliary stations, and the remaining eight to be kept at work until it became practicable to connect them with the others by transmission mains. The Commissioners, however, do not approve of this proposal. Their investigations show that it is more economical to build another super-power station in 1926 than to go on developing the stations which will then be in existence. To do this will involve less capital expenditure, and will reduce the annual cost of supplying electricity to the authorised distributors from 1·15d. to 0·98d. per unit. The new station will be situated at Barking. Unfortunately, members of the Committee of the Supply Companies are raising objections to this proposal. They desire that the whole of the financial control of the joint authority's work should be in the hands of those members of that body who provide the necessary capital. Seeing, however, that they obtain an extension of their tenure as distributors, it ought not to

be difficult to arrive at a compromise. The Commissioners anticipate that no political difficulties will arise to prevent this pooling of engineering resources. The prospects of real progress being at last made are therefore favourable.

THE first of the Christmas course of juvenile lectures at the Royal Institution on Electric Waves and Wireless Telephony by Prof. J. A. Fleming will be delivered next Thursday, December 29, at 3 o'clock, on "Surface Waves on Liquids." The succeeding lectures will deal with "Waves in Air," "The Telephone," "Electric Oscillations," "Electric Waves," and "Wireless Telephony."

THE extraordinary distances at which radio messages can be received is well illustrated by the fact that, except when atmospheric conditions are unusually bad, the messages sent from the Post Office station at Leafield are received at Perth, Western Australia. For instance, a news message of 448 words sent from Leafield on December 4 was heard at Perth, and was at once communicated to the Australian papers for publication. The Leafield station is the first station of the Imperial radio chain which is as yet only in course of erection.

As is well known, university professors and their families in Vienna are in dire distress. Amongst these is Prof. Tschermak, who may justly claim to be one of the most distinguished of living mineralogists. He is eighty-five years of age, and has a wife and daughter dependent on him. His pension, though large in kronen, is now equivalent to a sum of between 10*s.* and 1*l.* a month. His case appeals especially to members of the Geological and Mineralogical Societies, of which he has long been an honorary member. An endeavour is being made to secure for him during the coming year the means of existence. Prof. W. J. Lewis, University of Cambridge, and Prof. H. L. Bowman, University of Oxford, will gladly forward any sums sent in aid.

THE French Chamber has voted a sum of 50,000 francs for the purchase of the small house and garden at Sérignan, where for many years Jean Henri Fabre prosecuted his study of the habits of insects. Fabre died in the autumn of 1915 at the age of ninety-two. He had been a teacher at Ajaccio and Avignon before he retired, first to a little desert corner near Orange, on the Lower Rhône, and then to Sérignan, in the Department of Vaucluse. As an observer of insects he has been placed second only to Réaumur. He was made a Chevalier of the Legion of Honour and a corresponding member of the Institute, and his house has been a place of pilgrimage for many admirers of his writings. His heirs have consented to the house becoming national property, and his eldest daughter will fulfil the duty of guardian.

WE are glad to learn that Essex farmers have shown their appreciation of the valuable work of Prof. R. H. Biffen, professor of agricultural botany in Cambridge University, and of Mr. E. S. Beaven, of Warminster, in introducing Little Joss and Yeoman wheats and Plumage Archer barley respectively, by presenting two silver bowls to them. It may be remembered that the Darwin medal of the Royal Society was awarded last year to Prof. Biffen for his work on the inheritance of characters in wheat and barley. His new wheats—Little Joss, which owes its value to its immunity from yellow rust, and Yeoman, which combines high yield with first-class baking quality—are among the most popular wheats in England, and together account for practically one-half of the country's wheat crop.

IN reply to a question in the House of Commons, the Home Secretary stated on December 15 that as the result of a conference held with representatives of the French and Belgian Governments, an agreement was reached that the summer-time period should commence on the night of the last Saturday in March, or the last Saturday but one in March when the last Saturday is the day preceding Easter Day, and end on the night of the first Saturday in October. In view of the serious inconvenience at present caused by the difference between the three countries in the dates of commencing and ending summer-time the Government has approved the proposal, which corresponds very nearly to the dates which have been fixed in this country. It is intended early next session to introduce a Bill to give effect to this proposal.

THE suggestion has been made that part of the German reparation indemnity should be paid by the construction in this country of electric generating stations and the carrying out of railway electrification by German contractors. The council of the Institution of Electrical Engineers in a letter to the Prime Minister states its objections to the proposal. It points out that if German plant is to stand as a contribution towards reparations its value must be paid for by the undertakings using it. There is no reason, therefore, to suppose that users would get a cheaper service than with new equipment of British manufacture. Moreover, it would certainly largely increase unemployment in several of the electrical manufacturing industries. Any possible immediate advantage could not offset the possible ruin of the manufacturers of steam turbine plant and heavy electrical machinery, both of which had their sole origin in British science and inventiveness.

THE third International Congress of the History of Medicine will be held in London under the presidency of Sir Norman Moore on July 17–22 next. Meetings will be held at the Royal Society of Medicine, the Royal College of Physicians, the Royal College of Surgeons, and the Welcome Historical Museum, where there will be an exhibition of objects connected with the history of medicine, surgery, and the allied sciences, including ancient manuscripts, early printed books, etc. The subjects suggested for discussion are as follows:—(1) The principal seats of epidemic and endemic disease in the Middle Ages, including plague, gangrenous ergotism, leprosy, and malaria, and (2) the history of anatomy. Further information may be obtained from the general secretary, Dr. J. D. Rolleston, 21 Alexandra Mansions, King's Road, London, S.W.3.

ATTENTION was recently directed to the importance of mapping from the air, especially in the preliminary survey of routes for new railways and roads, approaches to possible harbours and prospecting of all kinds. Prof. B. M. Jones gave in the *Times* of December 13 some indication of the kind of experimental work in this subject which is being pursued at Cambridge under his direction, with the co-operation of the department of geography in the University and the financial assistance of the Department of Scientific and Industrial Research. For aerial photography to be of value for accurate survey it is essential to know the angular position of the camera when the photographs are taken. While it is possible to calculate the tilt from the position on the plates of known ground-marks which have been independently surveyed, a more satisfactory solution of the problem is to improve the flying until the camera varies from the correct position only within a certain permissible angle. Experimental work at Cambridge has been mainly in this direction, but has also touched the further problem of flying so as to cover the ground without gaps or excessive overlapping between the strips of photographs.

AT the annual general meeting of the Faraday Society held on December 13 the following officers and council were elected for the forthcoming year:—*President:* Prof. A. W. Porter. *Past-Presidents:* Mr. J. Swinburne, Sir R. T. Glazebrook, and Sir Robert Hadfield. *Vice-Presidents:* Mr. W. R. Cooper, Prof. C. H. Desch, Prof. F. G. Donnan, Dr. J. A. Harker, Mr. E. Hatschek, Prof. T. M. Lowry, and Dr. G. Senter. *Treasurer:* Mr. R. L. Mond. *Council:* Prof. A. J. Allmand, Dr. H. Borns, Mr. Cosmo Johns, Prof. W. C. McC. Lewis, Prof. J. R. Partington, Mr. C. C. Paterson, Dr. J. N. Pring, Prof. A. O. Rankine, Dr. E. K. Rideal, and Sir Robert Robertson. In the annual report it was stated that during the past year four general discussions had been held, three of them in co-operation with other societies. Reports of the proceedings of these discussions had been published. An appeal was made for an increased membership, without which it would be difficult for the society to keep pace with its increasing activities without a higher subscription.

THE following fellowships for medical research each of the annual value of 400*l.* have been awarded by the Trustees of the Beit Memorial Fund. The proposed subject of research and place at which the work will be carried on are indicated for each fellow:—Mr. R. K. Cannan: Studies in some chemical aspects of metabolism and digestion, at the Institute of Physiology, University College, London. Mr. H. D. Kay: The degradation of carbohydrates and allied substances by micro-organisms, at the Lister Institute, Chelsea. Miss Mary K. F. Lander: Examination of optic regions in primate brains, clinical observations, and physiological experiments with the view of ascertaining the crucial stages of the evolutionary process of development of stereoscopic vision and conjugate movements of the eye, at Department of Human Anatomy, University College, London. Dr. H. Goldblatt: The quantitative relation of fat-soluble A deficiency to the development of rickets (experimental rickets); the effect of parathyroidectomy on immunity, with special reference to its effect on the natural resistance of the rat to tuberculous infection, at the Lister Institute, Chelsea. Dr. L. Gross: Microscopic and macroscopic investigation and experimentation in the condition known as "intestinal stasis," at the Royal College of Surgeons and the Zoological Gardens, Regent's Park. Dr. Ethel M. Luce: Accessory food factors, with special reference to the relationship of ductless glands to calcium metabolism, at the Lister Institute, Chelsea.

THE *Review of Applied Entomology*, which is devoted to abstracts of the literature of that subject, unlike many other publications, has not had to curtail its pages owing to financial stringency. An index to the literature of agricultural entomology which has been abstracted in vol. 8 has lately been issued, and occupies nearly 200 pages printed in double columns. The size of the index indicates the vast amount of literature that is dealt with in the course of a year by the experts on the working staff of the Imperial Bureau of Entomology.

THE curator of the Hull museums is active in making known all accessions and other features of interest by small pamphlets, frequently reprinted from his own articles in the local newspapers, and sold at twopence each. In 1908, as publication No. 48, he issued an index to the previous forty-seven publications, and now, as No. 96, he sends us the index to Nos. 49–95. By this time, however, the serial number has mounted to 123, which last is a descriptive catalogue of exhibits temporarily arranged at the Wilberforce Museum in celebration of Andrew Marvell's tercentenary. Another of these most useful indexes may, therefore, be expected before long.

AN important new map of the Tibesti, Borku, Erdi, and Ennedi regions in the heart of the Sahara is published in *La Géographie* (vol. 36, No. 3). The map, which is on a scale of 1 : 2,000,000, is the outcome of Col. J. Tilho's work in that region between 1912 and 1917. Previous cartographic material was of a scanty nature, consisting, as it did, of rough itineraries, of which Nachtigal's seems to have been the most important, although it did little more than touch the western edge of the Tibesti region. No preliminary material included any astronomical positions. Col. Tilho's survey was based on Faya, the position of which was determined with great accuracy.

THE report for the year 1920 of the museums of the Brooklyn Institute of Arts and Sciences gives details of Mr. R. C. Murphy's expedition to the Peruvian Littoral. Reports on this work have appeared serially in the *Museum Quarterly* since April, 1920. In June we noticed Mr. Murphy's visit to the guano islands, and we now find in the April number of the *Museum Quarterly* an interesting account of Independencia Bay, which harbours giant crabs, huge mussels, and other big things, including, on occasion, the British Pacific fleet. A number of motion pic-

tures were taken by Mr. Murphy, and his collections are said to comprise practically the entire terrestrial life of the Peruvian islands, together with geological samples, a series of sea fishes, and invertebrates collected during tow-net hauls in the Humboldt current.

UNDER the title of "Notes Relating to the Aboriginal Tribes of the Eastern Province" Mr. I. Hewitt, in the *South African Journal of Science* for 1920, discusses some relics of a pre-Bushman race. We have, in the first place, stone implements which are supposed to be analogous to those of the period of Neanderthal man in Europe, though the question of the age of the gravels in which they are found has not been determined with certainty. Next come the remains in the coastal districts, consisting of extensive shell-mounds which are ascribed to the so-called Strandloopers, who fed on shell-fish and other marine products. In the course of this scholarly paper Mr. Hewitt collects the historical data regarding the Hottentots and Bushmen. From the craniological evidence the coast population seems to have consisted of bastard tribes containing Bushmen, Hottentot, and Kaffir elements. One skull appears to resemble the "Proto-Egyptian" type described by Prof. Elliot Smith. This is, if true, significant, because some authorities have suggested on linguistic grounds a relationship between the Hottentots and various northern pastoral tribes, one of which, the Gallas, makes use of clicks. At present the evidence in support of this theory is scanty, but further investigations in South Africa may lead to the settlement of an interesting problem.

THE annual part of the Transactions of the Norfolk and Norwich Naturalists' Society (vol. 11, pt. 2, 1921) reflects in excellent manner the activities of this admirable local society. Mr. B. B. Riviere, the president, leads off with a wealth of new observations towards the solution of the hitherto rather mysterious phenomenon of the daily autumnal migrations of gulls on the Norfolk coast. The account is full of interest and deserves wide publicity. Other bird papers include an attractive account by Mrs. Watson of the methods used in the taking of a census of eggs of the common tern on Blakeney Point, together with notes on the nesting habits of these birds, and a short authoritative statement by Dr. Sydney Long, the secretary of the society, of what is being done towards reorganising, correlating, and extending the measures for bird protection in the county. On the botanical side Mr. W. G. Clarke and Mr. Robert Gurney contribute a valuable study of the biology and distribution of the bladderwort (Utricularia), whilst Mr. Clarke, in another article, revisits the botanical localities (for Norfolk) mentioned in Dawson Turner's "Botanists' Guide through England and Wales" (1805). The part closes with notes of local interest and with obituary notices. The number is in all respects a valuable one.

THE researches of Prof. Hamburger, of Groningen, on the permeability of cells have been of continuous interest in their various developments since he investigated the laking of red corpuscles in dilute salt solutions more than thirty years ago. A convenient summary and survey of the whole was given by him in a lecture delivered at the University of London in June last which appears in the *Lancet* of November 19. That cells absorb some things from solutions and fail to take up other substances is a well-recognised fact. This has been attributed to a differential selective activity on the part of the living cell, closely correlated with its physiological needs, the precise psychological attitude of the cell varying with the particular sort of neo-vitalism which advocates it. Prof. Hamburger, on the other hand, premises a purely physico-chemical problem, and urges with considerable cogency that the intricacy and efficiency of these processes is commonly under-estimated. He shows, for example, how permeability may be altered by changes in the conditions and environment; carbon dioxide profoundly modifies the permeability of red-blood corpuscles and the permeability of the kidney glomeri to sugar is entirely changed by alterations in reaction of the liquid in which the sugar is dissolved. Emulsions, with which he thinks the boundaries of cells may fairly be compared, contain liquid pores which vary in shape and size according to the exact composition and concentration of the reacting substances, and he frankly attributes to their varying configuration some of the apparently anomalous instances of "selective" permeability.

THE Ministry of Agriculture has just published in collected form its leaflets dealing with the cultivation and diseases of the potato, the insect pests of fruit trees, and the fungus pests of fruit trees, and these three sectional volumes make a very welcome addition to the literature on diseases of plants in this country. The text of the leaflets has all been rewritten and brought up to date, thus representing the most modern outlook on the subjects considered, and each little volume opens with a very happy introductory chapter. In fact, each book is a partial monograph on the specific host plants, and combines in a somewhat rare manner a summary of the latest scientific investigations on the particular diseases and some very practical measures of prevention and control. The letterpress is good, and the illustrations in many cases noteworthy. These little books are indispensable to practical growers, and should be in the possession of all students of agricultural colleges or agricultural and botanical schools of universities; they really form the nucleus of what might with a little energy be expanded into a standard text-book on English plant diseases. A very great deal of credit is due to Messrs. Cotton and Fryer, who have compiled these volumes, and to the Plant Pests and Publications Branches of the Ministry of Agriculture for having had sufficient imagination to publish them in so attractive and convenient a form. It only remains to add that the price of two of the volumes is eightpence each, and of the third tenpence, and they are probably the best value in biological literature to be had for the money.

THE law of the geoidal slope and fallacies in dynamic meteorology is the subject of an article in the *Monthly Weather Review* for October, 1920, by

Dr. C. F. Marvin, chief of the U.S. Weather Bureau. Referring to the action of gravity upon bodies moving over a rotating globe, it is said to be expressed in two wholly independent inertia reactions; one, the law of equal areas, is stated by the author to have been fully recognised; the other action, though known, is said never to have been christened, and its important part in controlling the motions of the air is said to have been overlooked and misunderstood. Dr. Marvin names this neglected principle the law of the geoidal slope. Detailed quotations are given from popular and mathematical writers, and their errors are pointed out. The article concludes with a number of categorical statements, giving important principles which the motions of the atmosphere must satisfy. This paper by Dr. Marvin formed the subject of the discussion at the Meteorological Office at the first lecture-meeting of this season, which was opened by Sir Napier Shaw. A notice of the meeting at the Meteorological Office and of the discussion on Dr. Marvin's paper is given in the *Meteorological Magazine* for November, and after a little criticism it sums up with the following remark: "Although the points brought out by Prof. Marvin are familiar to most workers on dynamic meteorology, the publication of the paper should call attention to the weak spot in many text-books, and so improve the standard of teaching the subject."

WHEN an electric current passes through a long tube containing gas at a low pressure, one of the most striking effects is the alternation of intensity of light in the column of gas in contact with the positive electrode. The reasons for the alternations of electric field on which the alternations of light depend were stated in a general way by Sir J. J. Thomson in his "Discharge of Electricity through Gases," but in the December issue of the *Philosophical Magazine* he gives these reasons a more definite and precise form. By assuming that the current in the tube is carried entirely by the electrons, he reduces the mathematical difficulties considerably, and arrives at the conclusion that when the pressure is less than a certain minimum determined by the nature of the gas there will be at the end of the column nearest the cathode periodic variations in the luminosity, which will decrease in magnitude as the positive electrode is approached, and that these variations will be superposed on a continuous luminosity. These conclusions are in agreement with observation

WHEN running small electric motors it is necessary, as a rule, to have resistances in the circuit at the start which can be cut out when the speed of the motor is sufficiently high. Bare resistance wires are often used for this purpose, but as a rule they soon become very brittle, and so have periodically to be replaced. We recently had an opportunity of testing two zenite resistances manufactured by the Zenith Manufacturing Co., of Willesden Green. They consist of wires embedded in vitreous enamel. One of them carried the rated current successfully for several hours, but the other cracked slightly, the wire becoming exposed The makers state that the thermal coefficients of expansion of the wire of the porcelain, and of the enamel in which it is embedded, are the same. As a rule, however, the temperatures of the three substances will not be the same, and therefore there will be a tendency to crack. The zenite units should prove very useful in a laboratory, as they can be used for regulating the voltage applied to a consuming device in an electric circuit.

VOL. 14 of Contributions from the Jefferson Physical Laboratory and the Cruft Electrical Laboratory of Harvard University is a reprint of twenty-eight papers issued from the laboratories during the years 1919 and 1920. They cover a wide field, and include twelve on X-rays by Prof. W. Daune and his pupils, seven on spectra (two of which are from Prof. Lyman), and six on apparatus for high pressure and the properties of materials at such pressures by Prof. Bridgman. Of the latter one of the most important is that on the effect of pressure on the electrical resistivity of metals both in the solid and liquid states, from which it appears that the change of resistivity of a metal on melting follows the change of volume. The rate of increase of resistivity with temperature is generally less for the liquid than for the solid, and normally the resistivity of solid and liquid decreases as the pressure increases. Prof. Bridgman concludes from his work that the amplitude of the atomic oscillation is the principal factor in determining these changes of resistivity, and he puts forward a new theory of electrical conductivity in metals according to which the electrons of the older theories are not turned back by impact with the atoms, but pass through the latter freely. He shows that this theory reproduces the experimental facts much better than any theory previously advocated.

IN *La Nature* of November 12 M. Lémonon continues, and concludes, his articles on tidal power. The present article illustrates and describes a number of suggested methods of developing power by the use of one or more tidal basins filled at high tide and discharging through hydraulic turbines during the falling tide. Such an installation developing 70 h.p. for about five hours each day, situated at Saint-Jouard-des-Guerets, on the Rance, is illustrated. The use of single- and double-basin systems is discussed, and the barrage arrangements in a number of suggested schemes are dealt with in some detail. The article is purely descriptive, and does not attempt to deal with the efficiency of the various methods outlined or with the financial and economic side of tidal-power development.

THE National Research Council of the United States has issued as its fourteenth bulletin a "General Survey of the Present Status of the Atomic Structure Problem," by Profs. D. L. Webster and L. Page. The former author has contributed a general account of the phenomena, illustrated by diagrams, whilst the latter has given the principal equations which Bohr, Sommerfeld, and others have used in exploring the problem of atomic dynamics. This survey will be welcomed by readers who have not the time or

the opportunity to read the original papers, and perhaps more especially by chemists who are intimately concerned with the results of such investigations, but may not have been trained to the point of being able to follow in detail the methods by which the results are reached.

A NEW method of automatic electric welding was described to the Institution of Electrical Engineers on December 1 by L. J. Steele and H. Martin. Welding by means of an electric arc has long been practised by electrical engineers, but it has drawbacks since the mechanical strength of the weld is sometimes unsatisfactory. As the result of a lengthy experimental research the authors find that when the following sequence of operations is carried out the weld is always successful. In fixing a brass stud to a steel bulkhead, for instance, an arc is first struck automatically between the stud and the bulkhead. The stud is then moved in the direction of the arc until it makes firm contact with the steel. The current is then broken after a brief interval. The whole operation is done automatically, and perfect welds have been obtained between brass or manganese-bronze studs and steel, iron, or brass plates. The method solves the problem of electrically welding metals of widely differing character and very different cross sections. It is of particular value in ship construction, since it does not weaken the bulkheads or make them less watertight. It will be of value, also, in bonding rails together for electric traction.

PART 2 of Messrs. Wheldon and Wesley's Botanical Catalogue (New Series, No. 3), has just been issued. It contains nearly 6000 titles, classified as follows: early botany; Linnæus; botanical journals and transactions; botanic gardens; history, classification, nomenclature, biography, etc.; structural botany and text-books; phanerogams; fossil botany; flora of British islands; local British floras; flora of Europe; flora of Asia; flora of Africa; flora of America; flora of Australasia; diatomaceæ, desmidiaceæ, etc.; marine algæ; fungi; lichens; musci et hepaticæ; filices. It should certainly be seen by all who are on the look-out for books and journals dealing with botany. Copies of the catalogue are obtainable upon application to the publishers, 38 Great Queen Street, W.C.2.

THE latest catalogue of Mr. F. Edwards, 83 High Street, Marylebone, W.1, is No. 421, dealing with books on anthropology, folk-lore, and archæology, including the early history of man, native races, manners, customs, and beliefs, mythology, folk-lore tales, magic, and witchcraft. Upwards of 1100 works are listed.

MR. FREDK. J. BRODIE writes to point out that in the article on "Science in Westminster Abbey," which appeared in NATURE of December 1, p. 437, Dr. William Spottiswoode, who died in 1883 while president of the Royal Society, was incorrectly referred to as "Sir" William Spottiswoode.

Our Astronomical Column.

THE MARKINGS ON JUPITER.—The planet Jupiter will rise on December 25 at 1.14 a.m., and will be visible thereafter until sunrise. It will be due south at an altitude of 33° at 6.50 a.m., and is now favourably visible for the study of its surface features.

Mr. W. F. Denning writes:—"Some interesting observations have recently been obtained by Mr. Frank Sargent, astronomer at the University Observatory, Durham. On December 9 the South Temperate Disturbance, which consists of a dark irregular mass of material and has remained visible for twenty years, was well seen, and its following end came to the central meridian at 17h. 46m. G.M.T., so that its equivalent longitude was 143° (System II.). On December 12 the preceding end of the same marking was estimated central at 21h. 5m. G.M.T., longitude 354°.

"The length of the object was therefore 149°. Its rotation period, when compared with an observation on June 23 last, was 9h. 55m. 30s. On December 12 the red spot hollow was also observed, and its centre was remarked in transit at 18h. 31m. (longitude 260·9°). This value, combined with one derived by Mr. Sargent on May 24 last, shows the intervening rotation period to have been 9h. 55m. 37·8s. The latter marking has been visible for more than ninety years, for Schwabe at Dessau observed, and made a drawing of, the same feature so long ago as September 5, 1831.

"This hollow or basin in the great southern equatorial belt of Jupiter has undergone many changes since its first discovery, and it has been one of the most conspicuous features on the planet, as well as one of the most frequently observed, for it borders the northern side of the great red spot which became a striking object on the planet in 1873."

THE ULTRA-VIOLET SPECTRUM OF α CYGNI.—The resemblance between the spectra of novæ about the time of maximum luminosity and the spectrum of α Cygni has been very generally recognised, the spectrum of Nova Cygni III, taken at the Norman Lockyer Observatory last year, having proved this conclusively. The star α Cygni is one which is increasing its temperature, and is termed a Giant; in fact, it is of great importance in the domain of stellar evolution because there are few stars in the heavens which it resembles. For many years its spectrum was considered very peculiar, no one being able to state the origins of most of the lines. It was, however, solved at last, and, as Mr. W. H. Wright writes, "it required the genius of Lockyer to recognise the stellar lines as belonging to groups of metallic radiations which are stronger in the spark than in the arc." Up to the present time its spectrum has been closely studied in the region ordinarily recorded on stellar spectrograms, namely, from K to Hβ, but the ultra-violet section has taken second place. Any investigation which restricts itself specially to this ultra-violet region is therefore very important, especially if there exist spectra of novæ for comparison taken in this region. Mr. W. H. Wright (Lick Observatory Bulletin No. 332) now fills up this gap by making a detailed examination of this region in the spectrum of α Cygni, and publishing a set of wave-lengths extending from Hδ (λ 4102·0) to λ 3245. Further, he compares these values with some records of the ultra-violet spectra of some of the brighter novæ taken at the Lick Observatory. The result of his comparison is to show that the resemblance between novæ near maximum and the spectrum of α Cygni "is found to be even more striking in the ultra-violet than in the violet and blue regions."

The Origin of the Scottish People.

ON September 9, in the course of the meeting of the British Association at Edinburgh, a discussion on the origin of the Scottish people was held in a joint session of Sections E (Geography) and H (Anthropology), Lord Abercromby, president of Section H, being in the chair. The discussion was opened by theses maintained by Sir Arthur Keith and Prof. T. H. Bryce.

Sir Arthur Keith said that the inhabitants of the Highlands and western parts of Scotland and the inhabitants of the inland parts of Scandinavia were branches of the same racial (Nordic) stock. Seventy years ago Anders Retzius in Sweden and Sir Daniel Wilson in Scotland maintained that the Highland or Celtic Scot and the central Scandinavian showed the same type of head and the same form of body. A comparison of the results of more recent investigations carried on in Scotland and in Sweden and Norway made it certain that Scot and Scandinavian are traceable to a common source. Prof. Carl Fürst, of Lund, maintains that the inland inhabitants of Scandinavia are the descendants of the people who settled in Norway and Sweden on the retreat of the last ice-sheet. All the evidence favours the opinion that the modern Highlander is the lineal descendant of the people who reached Scotland at a corresponding period.

Scandinavian geologists estimate the beginning of the emergence of Scandinavia and Scotland from ice to a period of about 11,000 B.C. The North Sea was then an estuary or bay open to the north, with a western shore leading up to Scotland and an eastern leading to Scandinavia. On the Danish, as also on the Scottish, coasts are found the shell heaps of the "harpoon" folk—the earliest inhabitants of the north-western outskirts of Europe in post-Glacial times. The culture of this people is to be traced to countries in the south-west of Europe, and, although their remains have not been found, we may safely infer that they arose from the long- and big-headed type of man found in South England and on the Continent at the close of the Ice age. It was thus maintained that Scot and Scandinavian were descendants of the late Palæolithic men of South-West Europe.

The accepted opinion that the late Palæolithic races of South Europe had dark hair, eyes, and complexions is probably well founded. Fair hair, light eyes, and clear complexions, which find their fullest expression in the inhabitants of Baltic lands, are best regarded as characters recently evolved. The darker hair and eyes of the modern Scot, as compared with his Scandinavian cousin, may not be due to a later Mediterranean admixture, but to his retaining to a greater degree the complexion of his Palæolithic ancestor. The evidence gathered in all countries round the North Sea points to an increase in stature amounting to 3 in. or 4 in. since Neolithic times, showing that evolution as well as admixture had been at work.

If we suppose that the northward drift of the "harpoon" people took place at the beginning of the Neolithic period—some 6000 or 7000 B.C.—we have to leave about 4000 or 5000 years as a blank in the history of the Scottish people, for it is not until the beginning of the second millennium B.C. that we have trustworthy facts to guide us. At the beginning of this period we find Scotland in free communication with Europe by two portals. Through her eastern coasts she was open to the opposite shorelands of the North Sea and to Central Europe. Graves of this period contain the remains of a peculiar and round-headed people. Lord Abercromby has traced the designs of their pottery to the upper reaches of the Rhine. To this day the effects of the round-headed invasion can be traced in the population of the eastern counties of Scotland and of the coast-lands of Norway and Sweden.

It is quite feasible that the Celtic and Teutonic tongues may be modifications of the speech which reached western Europe in the mouths of the round-head Neolithic invaders. At the same time the pulse of south-western Europe—of the Mediterranean—was beating on Scotland at the western or back door, along what may be called the Celtic sea-passage—St. George's Channel, the Irish Sea, the western shores, to Orkney and to Norway. By this route Ireland and Wales received new settlers from south-western countries of Europe, but did they reach Scotland? Prof. Bryce is of opinion that the people buried in the western megalithic tombs of Scotland represent invaders of the Mediterranean type. They may equally well be considered as the native Nordic people of Scotland; indeed, in such skulls as retain the face there are certain features which suggest a northern origin.

There is no definite evidence of any great invasion of Scotland from the second millennium to the arrival of the Romans. The Roman invasion left no appreciable mark on the Scottish people. But in the fifth century, when the Romans were gone, both eastern and western doorways became again open and busy with visitors. The Dalriad Scots from the north of Ireland entered by the western portal; they may have brought a tongue which was new to Scotland, but they brought no new physical type. From the fifth century onwards, for a period of 500 years, Scotland received at her eastern doorway settlers from the coast-lands on the opposite side of the North Sea. They came from lands which, like Scotland, were first settled by the "harpoon" people. They brought Teutonic dialects to Scotland, other manners, traditions, and arts, but no physical type of manhood which was new to Scotland.

Who were the Picts? The people of Aberdeenshire were Picts in the ninth century; there is no reason to question that the bulk of the present population of that county are their children. An Aberdeenshire man cannot be recognised from another native of Scotland except by his speech. The Picts, Celts, and Saxons of Scotland are all of one breed—the descendants of the pioneer race which settled in North-West Europe when the last ice-sheet lifted. There has been only one intrusive element—the round-head of late Neolithic introduction.

Prof. T. H. Bryce said we now know that Scotland was inhabited as far back as Azilian times. We have no direct evidence regarding the physical characters of these early inhabitants, but there is a strong presumption that the primitive basis of the population was Nordic in character. Superimposed on this came, first, in late Neolithic times, the men of the chambered cairns, and second, the Beaker folk of the Bronze age. These three elements, blended in different proportions, made up the population of pre-Roman times, since when it has been altered only by the intrusion of similar elements and reassemblage. In South-East Scotland there are traces of a new element in the Iron age with a late La Tène culture. It resembles the Gaulish, but the interments are native, not Gaulish. The distribution of the chambered cairns and burials of the Bronze age indicate a grouping of the elements which, taken in conjunc

tion with the movements of historical times, explains the well-known features of the present-day population.

In declaring the subject open for discussion the president, Lord Abercromby, referred to the high percentage of broad-headedness found in the Island of Borreby, and expressed a doubt as to whether, at any rate in very early times, immigrants into these islands had used the direct route across the North Sea.

Dr. J. F. Tocher dealt mainly with the modern inhabitants of Scotland. In the course of his investigations of the physical character of the Scottish people he had made observations on some 13,000 individuals in all, the data obtained including head measurement, stature, and pigmentation. He had found the average stature to be 67½ in. The cephalic index showed wide variation, the inhabitants of the north-east being broad-headed and of the south-west long-headed. In absolute size the Aberdeen head was less than that of the rest of Scotland. In the north-east there was a significantly greater proportion of red hair. Speaking generally, he deprecated any conclusion as to the origin of the Scottish people based upon physical character on the ground of the relative paucity of the data.

Prof. R. W. Reid said that as a result of a number of observations made upon the inhabitants of North-East Moray, it appeared that the average stature was 5 ft. 7½ in., while the head form was mesaticephalic, approaching broad. They were almost identical with the young men of Norway. An examination of skeletal remains of the short cist people, approximately from the same tract of country, gave a stature of 5 ft. 4 in., with a cephalic index of 85. It might be agreed that a combination of long and broad heads afforded a clue to the physical characters of the people of this part of Scotland.

Prof. Jehu said that man existed in Scotland at the time of the formation of the 45-ft. raised beach, for which the accepted date was 10,000 years ago, while in southern England Neolithic implements had been found in the submerged forest. When man entered Scotland the Highland valleys were filled with ice. Owing to lack of evidence, it was dangerous to speak of the physical characters of the "harpoon" folk. There were no data to show they came from Scandinavia. The Scottish people were a very mixed race, and more evidence was needed before any conclusion was drawn as to their origin.

In a communication from Prof. W. S. Watson, who was unable to attend on account of illness, it was argued that, although language was no criterion of race, it afforded evidence of influence, political, cultural, or economic. It was possible to trace the Celtic language in Scotland with certainty back to the fourth century B.C. The chiefs are described as uniformly fair-haired with blue eyes, like the rulers of Gaul in Cæsar's time, and as it by no means follows that all the population was of one type, they probably ruled over a dark-eyed subject people. Among non-tribal names preserved in early writings there were elements which well might be pre-Celtic.

Mr. H. J. E. Peake took exception to the loose use of the term "Nordic," which should be confined to the tall, fair-complexioned, blue- or grey-eyed people, whose chief characteristics were strength, courage, activity, and an intense admiration for the horse. Such a people were not likely to be descended from a sedentary, maritime race such as the "harpoon" folk, but must have been derived from a race which had evolved in the open spaces necessary for the taming and exercising of the horse. The Scottish people had evolved from a generalised type of long-headed people, but there was no true Nordic type until the end of the Bronze age. The leaf-shaped sword people had arrived on the east coast of Scotland about 1200 to 1000 B.C., and were in all probability the fair rulers to whom reference had been made. He had already suggested a possible Siberian origin for the "harpoon" or Maglemose folk, and had also suggested that they were responsible for the broad, possibly Mongoloid, element occurring among Scandinavian skulls. Still, they might be derived from a Palæolithic race in south-western Europe.

Prof. Fleure urged the desirability of a careful search, especially in the remoter parts of Scotland, for nests of survivals of Palæolithic types such as he had found in Wales.

Mr. D. Mackenzie pointed out the necessity for distinguishing between the Maglemose and Azilian harpoons, the former being of bone, while the latter were of horn.

An Agricultural Enterprise.

AN interesting and important development is recorded in the report under notice.[1] The Olympia Agricultural Co., Ltd., is a comparatively recent enterprise which is farming nearly 10,000 acres of land on strictly business principles, one of the first examples of the application of industrial methods to the exploitation of land in this country. The company's land lies in six estates, and, in addition, the Suffolk estate of the chairman of the company, Mr. Joseph Watson, amounting to some 7000 acres, is linked up with the operations of the research department. It is not possible here to discuss the actual operations of the company in equipping its estates, the additions to and reconstructions of the buildings in order to fit them for large-scale farming, the provision of cottages, water-supply, etc., nor, again, the stocking and management of the farms. From this purely commercial side it is evident that an experiment is being made of extraordinary value in handling English land in a wholesale instead of a retail fashion and in providing for agriculture an organisation and an equipment comparable to that appertaining to any other great industry. It has often been thought that in such a way only can intensive production and adequate labour conditions be ensured in agriculture, and the enterprise therefore becomes one of the utmost importance in our social and national economy.

The aspect of the enterprise that will, however, be of the most interest to the readers of NATURE is that the directors have from the outset been convinced of the necessity of scientific investigation in the conduct of their business. They have, therefore, set up a research department, just as a steel works includes a laboratory, and they have, further, been public-spirited enough to give to the public for the general benefit of agriculture the results of their investigations in this first annual report. The headquarters of the research department have been established on one of the company's estates at Offchurch, near Leamington, where in the old mansion a very complete equipment of laboratories, both biological and chemical, has been installed. Dr. Charles Crowther, formerly

[1] Olympia Agricultural Co., Ltd. Research Department. First Annual Report, 1921.

of the University of Leeds, and well known for his work upon the nutrition of animals and milk production, is director of the establishment, and takes charge of the work upon animal-feeding; Capt. Hunter, late of the Department of Agriculture in Ireland, is responsible for the plant-breeding work; and Capt. Gimingham, who was attached to the Research Institute at the University of Bristol, is concerned with soil problems. These heads of divisions, with twelve others, constitute the research staff.

The work set out in the report before us is necessarily of a preliminary character. The first business of a scientific establishment of this kind is to supply data for the guidance of the management. The varying soils of the estates have to be analysed and correlated with the results of manurial trials in order that the specific needs of each field as regards lime and the main elements of fertility can be defined. Variety trials of the principal crops have to be made so as to ascertain what kinds of grain and fodder crops yield best under the several conditions of soil and climate. Again, economic feeding rations have to be worked out by trial for the particular classes of livestock and the special purposes for which they are being kept. All this is not research, but the scientific control necessary to a business organisation.

Most of the present report is occupied in setting out such results, which may usefully be correlated with similar commercial trials, but do not present any essential novelty. Research is an affair of years, and wisely the director makes no promises and says nothing about the real investigations he may have initiated. It is clear, however, that new ground is being broken, particularly in connection with plant-breeding. The field bean, for example, has been taken in hand; on many soils it is a crop of considerable economic importance, which never seems to have received any serious attention from the seedsmen or the older race of plant-improvers.

The report may be obtained on application to the director at the Research Station, The Bury, Offchurch, Leamington. It is the first fruits of a movement of great promise to agriculture, and redounds to the credit of both the director and the founder of the company, Mr. Joseph Watson.

Optical Wedges.

WEDGES of tinted glass have been used for graduating light for experimental purposes during the last fifty years or so, and about five and twenty years ago Warnerke made annular wedges of pigmented gelatine. It is twenty years since the "Chapman Jones plate tester" was put on the market, the graduated portion of which is a pigmented gelatine wedge, the mould being cut into five pieces that are placed side by side for the sake of convenience. Optical wedges, therefore, have been well established as standard apparatus for a long time.

We have received from the firm of "Herlango," of Vienna (at the request of Prof. J. M. Eder) an example of "a new grey wedge photometer," called, after the names of those who have devised it, the "Eder-Hecht" photometer, the essential part of which is a pigmented gelatine wedge with a scale printed on the thin celluloid that covers its face. This, with a neatly made white wood printing frame, is the complete apparatus. The plate is 3 cm. by 16 cm., and the divisions of the scale are 2 mm. apart. But the scale is not a simple ladder. Every fifth line is numbered with its mm. distance from zero, and, in addition to the number, has on each side of it a short thick pointed swelling to emphasise it and render it more easy to see how far the light-produced image extends. For use with it the firm issues various sensitive papers, both printing out and development, a silver-chloride paper made according to the formula of Bunsen and Roscoe, and also a colour-sensitised paper. An extended table gives the relative light quantity, and also the "absolute light quantity in Bunsen-Roscoe units," represented by each 2-mm. division. Thus, given the suitable sensitive paper, the apparatus is ready for use and convenient. It is applicable to light measurement in connection with photography, meteorology, climatology, biology, light-therapeutics, agriculture, the designing of buildings, botany, photographic reproduction processes, etc. Photometers slightly varying from the above, as in steepness of gradation, length of the wedge, the character and coarseness of the printed scale, are provided when more convenient. For photographic plate sensitometry the wedge plate is 9 by 12 cm., and by the side of the ladder scale are four narrow graduated strips, red, yellow, green, and blue respectively.

Accompanying the photometer is a copy of a paper by Walter Hecht on the use of such photometers in plant culture and a copy of a paper by Prof. Eder published in the *Photographischen Korrespondenz* for September, 1919, in which he gives apparently every possible detail and formula in connection with these photometers. But he does a considerable injustice to the Chapman Jones plate tester in associating it with Warnerke's original step-tint sensitometer. It differs from the sensitometer designed by Prof. Eder in having a wedge from two to three times as long and divided into twenty-five parts instead of sixty parts. These twenty-five parts may be subdivided to any extent on mere inspection according to the observer's acuteness of vision. It has the four colours giving four definite parts of the spectrum, and, in addition, an Abney colour sensitometer, which shows at a glance whether a plate alone or a plate *plus* a colour filter gives the same density for equal brightness of several colours. We think, too, that comparing the density produced under any given colour with a scale of densities admits of greater precision than the estimation of the vanishing point of the image as is done in Prof. Eder's instrument.

C. J.

The South African Association for the Advancement of Science.

DURBAN MEETING.

THE nineteenth annual meeting of the South African Association for the Advancement of Science was held at Durban, in the Technical College, on July 11–16 last, under the presidency of Prof. J. E. Duerden. The meeting was well attended, and was very successful. More than fifty papers were read, and the time-table was so arranged that attendance at the presidential address of each section was possible for every member. An official welcome and a reception in the Art Gallery was given by the Mayor of Durban, while a conversazione was arranged by the local committee of the association and the Natal

Society for the Advancement of Science and Art. A number of interesting excursions to places of local interest were arranged.

A popular lecture, illustrated by lantern slides, was given by Dr. A. L. du Toit, geologist to the Irrigation Department, on "Land Connections between the other Continents and South Africa in the Past." The lecture dealt with the ancient continent of Gondwanaland, its glaciation, the spread of animal and plant life across it, its dismemberment, the development, geographically and biologically of the several portions, their temporary reunion, and finally the evolution of the present continental masses.

The South Africa medal and grant were presented to Sir F. Spencer Lister, bacteriologist to the South African Institute for Medical Research, Johannesburg, in recognition of his work on the differentiation of the pneumococci of lobar pneumonia into many immunologically distinct groups, and the successful application of the discovery to the artificial production of immunity against pneumonia in man.

The presidential address by Prof. Duerden was on "Social Anthropology in South Africa: Problems of Race and Nationality." A sketch of the rise of social anthropology was given, and the view was maintained that anthropological studies should contribute to the upbuilding of the State by offering a scientific understanding of the peoples within it. Such was very necessary in South Africa, with its very diverse stages of social evolution and its many distinct races and nationalities which should live together in harmony and build up a South African nation. The alleged aversion between white and black was discussed, and was shown to manifest itself only on an assumption of equality, the difference in the degree of civilisation being too great to be bridged. The Bantu is highly assimilative, but neither originative nor constructive, and hence is dependent on the European for his advancement. The fusion of racial groups in South Africa was discussed, and the opinion given that there would be no fusion, though the members would intermingle in ordinary avocations. Solidarity of race may be superseded by national bonds and loyalty under just and humane treatment. The retention of national aspirations of British and Dutch are not incompatible with a South African national solidarity. It was held that a new unifying South African nationalism was dawning, and that the future relationships of the European to the lower races must be that of a benevolent aristocracy of ability.

The presidential address to Section A, by Dr. J. Lunt, of the Royal Observatory, Cape Town, dealt with "Stellar Distances, Magnitudes, and Movements." The speaker reviewed briefly the development of astronomy, the oldest science, and discussed various spectrographic methods, especially in relation to the determination of the distances, sizes, and movements of stars. The work in astronomy in the United States was described at some length, and comparison made with the conditions prevailing in South Africa. The new universities of South Africa should play a part in the development of astronomical and astrophysical research here, where the study of the skies of the southern hemisphere was an essential complement to the work in the northern observatories. The address concluded with a vigorous appeal for the training of workers, for adequate equipment, and for a better appreciation of, and reverence for, the wonderful universe of which man forms so small a part.

Dr. J. Moir, in his presidential address to Section B, dealt with "The Atomic Theory of 1921." He showed the tremendous strides that had been made in the conception of atoms and molecules in the last twenty years. Two primitive materials, hydrion and electron, with two intermediate building substances, H_2 and H_3, as well as helium, are considered to be the basis of all elements. The constitution of a number of elements was explained and illustrated in detail, numerous examples being given. Many cases were cited in which physical means during the world's evolution may have acted on different substances; for example, strontium sulphate, yttrium phosphate, and zirconium silicate, which now have similar electron and ion constitutions, are three very different substances which may really be one, changed by external forces.

Prof. J. W. Bews took as his subject, "Some Aspects of Botany in South Africa and Plant Ecology in Natal," in his presidential address to Section C. The speaker sketched briefly the effect of environment on progress in botany. The history of botany widened the perspective, and it was interesting to note the progress of the science as transplanted into South Africa. The only indigenous botany was that of the natives, who possessed a wonderful knowledge of plants and their properties. Passing to botany in Natal, the speaker paid tribute to a number of pioneer workers, and proceeded to discuss the ecology of Natal more particularly. The coast belt, the midlands, and the Drakensberg or mountain region, were described, with their characteristic vegetations. The plant communities of Natal were discussed in some detail, as were plant migrations and the affinities of the Natal flora.

The presidential address to Section D was delivered by Prof. H. B. Fantham, on "Some Recent Advances in Zoology and their Relation to Present-day Problems." At the outset the field of pure science was discussed. Such must never be ignored, for the academic of to-day may be of the greatest technical benefit hereafter. Early specialisation for purely economic ends was to be deplored, for the specialist needed a breadth of outlook, an orientation in the whole field of his science, in order to have balance and perspective. The work done by protozoologists, helminthologists, and entomologists in the great war was referred to, and fields of work in South Africa indicated. Recent researches on ductless glands of animals were cited, and fisheries developments were noted. Many interesting results in connection with work on chromosomes and their relation with sex were quoted. Newer work in connection with the processes of evolution, especially in regard to heredity and acquired characters, was brought under review. The need for the application of biological principles in modern problems, including politics, was insisted upon. Heredity, environment, and response to stimulation needed concurrent attention. The higher standard of living for workers demanded more than mere amusement and indulgence in luxuries and excitement. Idealism was essential, and it was shown that religion and science were not necessarily in conflict. The speaker concluded with a plea for the inculcation of the spirit of biology in all education. With a widespread knowledge of history, biology, and sociology, man should improve his environment and attain co-operation, peace, and higher ideals.

Section E met under the presidency of Dr. C. T. Loram, who discussed "The Native Problem." The adjustment of white and black was difficult in South Africa, and a successful adjustment was held to be impossible without sacrifices on both sides. The chaotic political situation with regard to natives in the different provinces of South Africa was described. Legal procedures and jury systems were also mentioned, and it was a question whether the Roman-Dutch law of Europeans were best for the native on account of the differences between the two civilisations

concerned. The mentality of the native was analysed, and because of the lack of sublimation of the sex instincts, such as occurred in the European, there was not the same growth in ambition, idealism, and general achievement. The trade union movement among natives and their numerous religious bodies were mentioned, and European philanthropic leading was mentioned as being desirable. Location and taxation problems were discussed, and the co-operation of all scientists desired in solving the many problems connected with the native.

Prof. W. A. Macfadyen spoke on "Observations and Proposals for the Stabilisation of Money Values" in his presidential address to Section F. Inflation and deflation of currency were two of the greatest evils resultant on the great war, and they affected everyone. The stabilisation of money values and the preservation of such stability were shown to be the most fundamental interests of commercial, industrial, and democratic policies. National bankruptcy was defined, and it was shown that international exchanges had failed to act as bridges for commerce. The dissipation of capital during the war led to inflation, and the necessity for constant readjustment between wages and prices led to constant strikes and labour unrest. Legitimate trade and industry were replaced by speculation. Economic bankruptcy of a nation meant reversion to an archaic type of civilisation and the sacrifice for a time of all the artistic and professional values of civilisation. Fluid permeation of gold was shown to be necessary. The function of a central reserve bank was also discussed, and the function of the League of Nations in instituting an international currency reserve bank was indicated. The speaker summarised his points thus: The international export and investment of capital had woven the world into one financial system. Such an international system implied either a universal unit of account or an international banking system. The control of such a general standard of value so as to preserve an invariable ratio between goods and money was the most important of public and private interests.

It is only possible to mention some of the many papers read before the various sections, but most of them will be printed in the journal of the Association.

In Section A an interesting paper on asphalt in relation to road construction was contributed by Mr. D. B. W. Alexander; Mr. R. J. Norris spoke on the purification of sewage by the activated sludge process, and Mr. H. Clark gave notes on the occurrence of even harmonics in electrical current and pressure waves.

In Section B Mr. C. W. Petchell spoke on alcohol fuels for internal combustion engines. Mr. C. Williams gave notes on the chemical control of cattle-dipping tanks, a matter of much importance in South Africa. Dr. B. de C. Marchand gave an account of methods for the mechanical analysis of soils containing heavy minerals, and Messrs. Kloot and Hyman gave a paper on the chemistry of condensed milk.

In Section C papers were given by Miss H. Forbes on the Natal species of Cassia and on the flora of Isipingo. Dr. P. A. van der Bijl gave accounts of some interesting and little-known South African fungi, and of the fungi found in the air of sugar mills. Mr. R. D. Aitken described the plant succession in a type of midland tree veld in Natal, and Mr. G. W. Gale discussed the aeration systems of certain Natal plants. Prof. D. Thodav discussed the genus Passerina and its distribution in South Africa, and Dr. Sim contributed notes on the Bryophyta of Southern Rhodesia. A most interesting paper was contributed by Dr. E. Warren on the interspecific hybrid and back-cross of the foxglove, the paper being followed by a useful discussion. Two papers of special interest to agriculturists were contributed by Mr. E. Parish on agricultural experiment, its design and interpretation, and by Mr. A. O. D. Mogg on a method of veld estimation in relation to lamziekte. There was also a botanical excursion to Isipingo.

In Section D there was a discussion on South African Trematodes, in which papers by Dr. F. G. Cawston on *Bilharzia cercariae*, by Mr. F. W. FitzSimons on birds as possible carriers of snails, and so as distributors of Bilharzia, and by Dr. Annie Porter on experimental researches on various species of Schistosoma and Fasciola were first considered. Mr. J. Sandground gave a detailed account of the life-history of species of Heterodera in South Africa, and Mr. R. H. T. P. Harris described the beetle, *Ortalia pallens*. Mr. E. C. Chubb contributed a paper on the natural history and geology of Durban. Much interest was aroused by the account given by Dr. H. B. Fantham and Miss Esther Taylor of the Protozoa found by them in some South African soils. Dr. Fantham also described his further observations on parasitic Protozoa in animals in South Africa. Dr. Lindsay Johnson gave an interesting account of various methods for screening light observed in the eyes of vertebrates, beautiful lantern slides being shown. There was also a zoological excursion for observations on the animal life of Durban Bay.

In Section E Mr. D. A. Hunter discussed Bantu industries, Mr. W. H. Tooke dealt with natives and agriculture, and Mr. H. S. Keigwin gave an account of an educational experiment. Mr. S. S. Dornan spoke of the heavenly bodies in South African mythology; Mr. W. Wanger dealt with two Ntu problems, and Mr. A. J. Bryant gave an account of some native marriage rites. Prof. W. A. Norton read papers on the regiments of the house of Moshish, Sesuto praises of the chiefs and the Bantu idiomatist, and Mr. D. D. T. Jabavu contributed a paper on Bantu literature.

In Section F Mrs. Mabel Palmer discussed Irving Fisher's proposals for stabilisation of the value of money, and Mr. G. Burgess dealt with the taxation of land values. Mr. C. Graham Botha gave papers on archival problems in South Africa and on the preservation of our national monuments. Dr. J. E. Holloway spoke on decentralisation in university education and research. An interesting paper on the function of a school of art in the life of an urban community was given by Mr. O. J. P. Oxley, who illustrated his remarks by an exhibit.

The next annual meeting of the Association will be held in July, 1922, at Lourenço Marques, under the presidency of Dr. A. W. Rogers. H. B. F.

University and Educational Intelligence.

LONDON.—Dr. R. H. Aders Plimmer has been appointed as from January 1, 1922, to the University chair of chemistry, tenable at St. Thomas's Hospital Medical School. Since 1919 Dr. Plimmer has been head of the Biochemical Department of the Rowett Research Institute of Animal Nutrition at the University of Aberdeen and North of Scotland College of Agriculture, and research lecturer in applied biochemistry in the University of Aberdeen.

Mr. H. H. Dodwell has been appointed as from March 1, 1922, to the University chair of the history and culture of British Dominions in Asia, with special reference to India, tenable at the School of Oriental Studies.

Dr. Lewis Simons has been appointed as from March 1, 1922, to the University readership in

physics, tenable at Birkbeck College. Since 1917 Dr. Simons has been lecturer in physics at the South African College, now the University of Cape Town.

The following doctorates have been conferred: *D.D.*: Rev. W. R. Matthews, an internal student of King's College, Theological Department, for a thesis entitled "Studies in Christian Philosophy." *D.Sc.* (*Chemistry*): Mr. K. G. Naik, an internal student of the Imperial College, Royal College of Science, for a thesis entitled "The Interaction of Sulphur Monochloride with Substances containing the Reactive Methylene Group or Substituted Methylene Group." *D.Sc.* (*Economics*): Mr. Sih-Gung Cheng, an internal student of the London School of Economics, for a thesis entitled "Modern China: A Political Study."

MANCHESTER.—The following appointments have been made: Mr. C. B. Dewhurst, dean of the faculty of science; Dr. J. P. Buckley, lecturer in regional surgery; Mr. J. M. W. Morison, lecturer in applied anatomy; Dr. T. H. Oliver, lecturer in clinical medicine; and Mr. H. S. Leigh and Mrs. Leonore Pearson to honorary research fellowships.

THE honorary degree of Doctor of Science has been conferred by the University of Calcutta on Sir W. J. Pope, professor of chemistry, Cambridge University, and on Prof. C. V. Raman, professor of physics, University of Calcutta.

THE general council of the Trades Union Congress and the executive of the Labour Party passed the following resolution on December 15:—"That this joint meeting views with profound disappointment the apparent intention of the Government further to reduce expenditure on education, and in particular condemns the decision of the Treasury to reduce the annual universities grant from 1,500,000*l.* to 1,200,000*l.*, which can do virtually nothing to relieve the national finances, but which will be a serious blow to higher education."

THE twenty-second annual meeting of the Science Masters' Association will be held in the chemical department of the Imperial College of Science and Technology (Royal College of Science) on January 3–4 next. The president of the association, the Master of Balliol, will deliver his address on January 3, taking as his subject "Science and History." The topics for discussion on the first day of the meeting are The Teaching of Mechanics and The Teaching of Geography in Relation to Science, while Physical Chemistry in Schools and Post-Certificate Science for Non-Specialists will occupy the second day. Exhibitions of apparatus and books by members, instrument-makers, and publishers will be open during the meeting.

THE annual meeting of the Mathematical Association will be held at the London Day Training College, Southampton Row, London, W.C.1., on January 2 and 3 next. The following are among the papers to be submitted during the meeting:—Mathematics in Artillery, by Sir George Greenhill; The Structure of the Atom, by Prof. J. W. Nicholson; Vectors, by Prof. C. Godfrey; The Dalton Plan and the Teaching of Mathematics, by Miss F. A. Yeldham; and The late Srinivasa Ramanujan, by Prof. G. H. Hardy. There will also be discussions on the simultaneous teaching of pure and applied mathematics and on methods of keeping mathematics teachers in touch with modern developments of the subject. Sir Thomas L. Heath has been nominated president of the association for the years 1922 and 1923 in succession to the Rev. Canon J. M. Wilson.

Calendar of Scientific Pioneers.

December 22, 1590. Ambroise Paré died.—Surgeon to four Kings of France, Paré served through many campaigns, doing much to improve the treatment of wounds, especially by the substitution of ligature of the arteries for cauterisation with a red-hot iron after amputation. He is regarded as the father of modern surgery.

December 22, 1722. Pierre Varignon died.—In 1687, the year Newton's "Principia" appeared, Varignon published his work on mechanics based on the composition of forces. Like l'Hospital, he was a powerful advocate in France of the use of the differential calculus.

December 22, 1828. William Hyde Wollaston died.—Abandoning medicine for scientific research, Wollaston made investigations over a wide field and contributed much to chemistry and optics. He first noticed the dark lines in the spectrum, invented the camera lucida and a reflecting goniometer, showed the identity of galvanism and frictional electricity, and discovered palladium and rhodium. By making platinum malleable he gained a fortune of 30,000*l.*

December 22, 1887. Ferdinand Vandeveer Hayden died.—A great geological explorer, Hayden was prominently connected with the survey of the Western States of America and wrote valuable works on natural history and economic science. The idea of the National Park on the Yellowstone River was his.

December 23, 1901. Sir Joseph Henry Gilbert died.—The fellow-student of Lawes at University College, London, Gilbert worked under Liebig at Giessen, and in 1843 began his lifelong collaboration with Lawes in agricultural chemistry. For some years he held the chair of rural economy at Oxford.

December 23, 1907. Pierre Jules César Janssen died.—Janssen was the pioneer of spectroscopic astronomy in France. Well known for his scientific expeditions, in 1868 in India independently of Lockyer he discovered the method of observing the solar prominences in daylight. In 1876 he became director of the observatory at Meudon, and he also established a meteorological observatory on the summit of Mont Blanc.

December 24, 1872. William John Macquorn Rankine died.—Distinguished alike as an engineer and physicist, Rankine from 1855 held the chair of engineering at Glasgow and published standard text-books on various branches of engineering. His "Steam Engine" contained the first systematic treatise on thermodynamics, and he made important researches in molecular physics.

December 26, 1886. Theodor Ritter von Oppolzer died.—Professor of astronomy in the University of Vienna, Oppolzer paid special attention to theoretical astronomy, did valuable work on the European degree measurement, and published a "Canon der Finsternisse" containing the elements of eclipses of the sun and the moon from 1207 B.C to A.D. 2162.

December 28, 1850. Heinrich Christian Schumacher died.—The founder a century ago of the *Astronomische Nachrichten*, thirty-one volumes of which he edited, Schumacher held positions in Copenhagen and Mannheim, and in 1821 became director of the Altona Observatory.

December 28, 1899. Karl Friedrich Rammelsberg died.—Born in 1813, two years after Bunsen, Rammelsberg passed his life teaching and experimenting in Berlin, adding immensely to the knowledge of inorganic chemistry, mineralogy, and crystallography.

E. C. S.

Societies and Academies.

LONDON.

Aristotelian Society, December 5.—Prof. G. Dawes Hicks in the chair.—J. **Johnstone**: The limitations of the knowledge of Nature. A survey of the speculative biology of the late nineteenth and twentieth centuries forces one to the recognition of a twofold passage of Nature. According to the fundamental concept of physical science, the second law of energetics, viz. the augmentation of entropy, physical change tends continually to diminution. The universe, to use Bergson's term, is detending. To the biologist there is another aspect, for life is the incessant attempt of certain physico-chemical systems to resist the increase of entropy. The difficulty in accepting generalised relativity in biology is that for speculative physiology space-time cannot be completely isotropic, especially if we regard the quality of duration as the cumulative continuity of life. It is a passage, as well as the persistence, of that which has passed. We must regard Newton's "ocean of truth" as amorphous in structure. The relations that are to be discovered in it are in it only in the sense that they come into existence with the thought that makes the relation.

CAMBRIDGE.

Philosophical Society, November 28.—Prof. A. C. Seward, president, in the chair.—J. **Gray**: Note on cell-division. The form of a dividing cell is determined by three forces:—(1) The mechanical force exerted by the cell membrane, (2) the surface tension of the protoplasmic surface, and (3) an internal force which elongates the cell along the main axis of the astral figure.—J. M. **Wordie**: The geology of Jan Mayen. The island is entirely volcanic. The earliest lavas are biotite trachytes, which are post-dated by a conglomerate with wind-polished pebbles. No plant-bed nor anything to suggest the date of the earlier eruptions was found. A period of erosion probably took place between the formation of the southern hills and the much later Beerenberg volcano (8350 ft.). Olivine-basalt moderately rich in alkalis is the dominant rock type throughout the island. The latest volcanic outbursts were from parasitic cones near Beerenberg and from near Vogt Crater, some of lava, others of ash; they were recorded in 1732 and 1818. On Egg Bluff there are cracks from which steam still issues. Beerenberg itself has never been active in historic times; its crater, half a mile in diameter, is now ice-filled.—W. S. **Bristowe**: The insect and arachnid fauna of Jan Mayen. Most of the insects and arachnids also occur in Britain, Greenland, Novaya Zemlya, and Siberia. They may have reached the island from Britain and Greenland fastened to birds or sheltered in their feathers, and from Siberia in driftwood. The distribution of the spiders illustrates the theory of an ancient circumpolar fauna. Two species are found at high altitudes in the Swiss Alps, and all occur above 3000 ft. on Scottish mountains; in Jan Mayen they are found almost at sea-level and upwards. Spiders' eggs hatch out at the end of the season, thus avoiding loss of time when the thaw comes. The list includes five spiders, six mites, one tick, eight Collembola, twelve flies, two ichneumons, and a few water creatures.—J. L. **Chaworth-Musters**: The vegetation of Jan Mayen. The vegetation may be roughly divided into three groups: that of the sea-shore, of the bird cliffs, and of the mountains. Of true halophytic plants there are only two, *Martensia maritima* and *Arenaria peploides*. On the bird cliffs grows the most luxuriant vegetation of the island. The most characteristic points are the presence of luxuriant growths of *Taraxacum croceum*, *Saxifraga cernua*, Oxyria, and *Poa flexuosa*. Kœnigia is the only annual of Jan Mayen, and grows in most damp spots amongst cinders. The sandy wind-swept flats, where there is no driftwood, are destitute of vegetation, and there are no water-plants in the lakes. The remoteness of Jan Mayen from neighbouring lands and its volcanic character make the origin of the vegetation a difficult problem. Probably the most likely means for the transport of seeds are the feet of wading birds, which stop at Jan Mayen on their way to and from their breeding-grounds in Greenland.—Miss M. D. **Haviland**: The bionomics of parasitism in certain Hymenoptera. The hyperparasites of Aphides belong to the super-families of Cynipoidea, Chalcidoidea, and Proctotrypoidea. The first of these are internal, and the second and third external, parasites. Double infestations are common among the hyperparasites, and special terms are suggested to define these relationships.—M. S. **Pease**: Note on Prof. T. H. Morgan's theory of hen feathering in cocks.—S. **Wigert**: A problem concerning the Riemann ζ-function.

DUBLIN.

Royal Irish Academy, December 12.—Prof. Sydney Young, president, in the chair.—J. J. **Dowling** and C. J. **Haughey**: The electrification of smoke nuclei from phosphorus. If smouldering phosphorus is exposed to an electric field, the smoke particles are found to assume charges which depend on the intensity of the field. These charges were investigated by three methods, one a visual method, in which the mobilities of the particles were determined by observing the path of the smoke-stream in a vertical air-current when subjected to a horizontal electric field; the others involved a measurement of the electric charge carried by the smoke. The nuclei were found to be of uniform size and display a periodic increase in charge as the field is gradually increased, due probably to the successive addition of electrons. Charges of from one to twenty-five electrons have been so obtained.—J. J. **Nolan**: Ionisation in moist and dry air. The composite nature of the ionisation in moist air has been demonstrated by two methods. The bulk of the ionisation consists of four groups of ions of mobilities approximately 2, 1·8, 1·5, and 1·35 cm. sec. per volt cm. Other groups are present in small quantities, the most notable having a mobility of 12. With extreme drying the faster groups appear in greater quantity, and in the case of negative ions the four ordinary groups disappear. With extreme drying doubly charged positive ions also appear, showing that the act of ionisation by α-rays may involve the detachment of two electrons from the molecule. Evidence is found of the existence of free electrons in air at ordinary pressures.—R. A. P. **Rogers**: The simplest mode of representing a continuous linear orthogonal transformation by means of rotation and translation of a rigid schema in a Euclidean manifold of n dimensions. The transformation in question, with constants added, corresponds to a displacement of a rigid schema in S_n, which may be effected by a unique system of $n/2$ independent rotations, if n is even, or if n is odd by $(n-1)/2$ such rotations together with a unique independent translation. A method of reduction by means of invariants to the canonical form required is given.

PARIS.

Academy of Sciences, December 5.—M. Georges Lemoine in the chair.—F. **Roux**, H. **Vallée**, H. **Carré**, and the late M. **Nocard**: *Résumé* of experiments on aphthous fever. A summary of results obtained since

1901, dealing with the preservation of the virus, fallacies to be avoided in experimental infection, and the possibility of vaccination against the disease.—C. **Guichard**: The infinitesimal geometry of the linear complex.—M. Félix Mesnil was elected a member of the section of anatomy and zoology in succession to the late Edmond Perrier.—G. **Julia**: Meromorphic solutions of certain functional equations.—W. **Loth**: The solution of the problem of the direction of aeroplanes and dirigibles in mist or on dark nights. An application of an electrical method already successfully applied to ships.—E. **Carvallo**: Electromagnetism and the principle of relativity.—M. **de Broglie**: Corpuscular spectra and their utilisation for the study of X-ray spectra.—L. **de Broglie**: The degradation of the quantum in the successive transformations of high-frequency radiations.—G. **Reboul**: A new radiation of short wave-length. In an earlier communication an account was given of some experiments in which a feebly conducting body traversed by a current of electricity gave radiations marking a photographic plate. Further experiments show that the effects are not due to a new type of ray, but to ordinary radiations of a wave-length intermediate between the extreme ultra-violet and the X-rays.—F. **Michaud** and A. **Balloul**: The action of an electric field on an insulating liquid. A discussion of some results recently published by M. Bouchet.—L. **Brillouin**: The propagation of light in a dispersive medium.—A. **Pereira-Forjaz**: The spectroscopic study of a Portuguese meteorite.—A. **Pereira-Forjaz**: The spectroscopic study of some Portuguese tungsten minerals.—G. **Petit**, L. **Marchand**, and L. **Jaloustre**: The general effects of hypodermic injections of thorium-X upon the organism.—G. **Contremoulins**: The *rôle* of metroradiography in the establishment of endoprothetic pieces in dead bone.—E. **Grandmougin**: The intermediate products in the synthesis of alizarin.—P. **Lebeau** and M. **Picon**: The action of sodammonium on pyridine. The preparation of the hydrate of tetrahydrodipyridyl.—P. **Malvezin**, C. **Rivalland**, and L. **Grandchamp**: A new preparation of formaldehyde hydrosulphite and an economical generator of hydrosulphurous acid. Zinc dust is suspended in formaldehyde solution and sulphur dioxide added through the walls of a Chamberland filter; a strong solution of the zinc hydrosulphite formaldehyde is formed.—Mme. **Ramart**: The molecular transposition accompanying the dehydration of 1 : 1-diphenyl-2 : 2-dimethyl-1-propanol.—G. **Denigès** and R. **Tourrou**: The microchemical reactions of dulcine (*p*-ethoxyphenylurea).—A. **Schoep**: Curite, a new radio-active mineral. This mineral was found with chalcolite in the Belgian Congo. Analysis proved it to be a lead uranate of the composition $2PbO,5UO_3,4H_2O$. It is very radio-active, and the name "curite" is proposed for the mineral.—P. **Russo**: The fluvial terraces of Kiss, Sebou, and Ouergha (Morocco).—E. **de Martonne**: The platforms of erosion of the Bihar Mountains, Rumania.—Mlle. Y. B. **de Black**: Researches on the Mindelian epicycle in the high valley of Cère and on the plateau of Lacapelle-Barrez (Cantal).—E. **Eblé**: The periodicity of the microseismic agitation. It is known that seismographs record an almost uninterrupted movement of the earth's surface, consisting of a succession of waves of a period between 4 and 8 seconds and very variable amplitude. A rapid examination of the records of the Parc Saint-Maur Observatory has been made by giving a figure to each hour of the day, indicating by estimation the degree of agitation. The scale adopted was arbitrary, calling calm 0, very agitated 4, analogous to the old classification of stars by magnitudes. Taking a period of ten years a regular periodicity is shown, with a clear minimum in July and a maximum, not so clear, in January or February. There is also a diurnal and a semi-diurnal variation.—J. **Vallot**: The measurement of the influence of heat and light on the activity of reduction by animal tissues and applications to heliotherapy. The experiments show that the therapeutic action of solar radiation is explained by the strong increase of activity of reduction by the tissues which it causes.—P. **Courmont**, A. **Rochaix**, and F. **Laupin**: The rate and rhythm of disappearance of organic matter in the course of the purification of sewage by the method of activated sludge.—R. **Sazerac** and C. **Levaditi**: The action of certain bismuth derivatives on syphilis. Further clinical results have confirmed the remarkable activity of potassium tartarobismuthate in syphilis, and experiments with other bismuth salts are now recorded, including ammoniacal citrate of bismuth, bismuth lactate, bismuth sub-gallate, and bismuth oxyiodogallate. All the bismuth preparations are active against syphilis, but vary in toxic power on the organism. From the point of view of human therapeutics, the tartarobismuthate originally tried is the best.

Books Received.

The Metallurgy of the Common Metals. Gold, Silver, Iron (and Steel), Copper, Lead, and Zinc. By L. S. Austin. Fifth edition, revised and enlarged. Pp. xviii+615. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 42*s*. net.

Comité Spécial du Katanga. Contribution à l'Etude de la Flore du Katanga. By E. de Wildeman. Pp. viii+cxliv+264. (Bruxelles: D. Reynaert.)

Comparative Ethnographical Studies. By Erland Nordenskiöld. No. 4: The Copper and Bronze Ages in South America. Pp. viii+197. (London: Oxford University Press.) 18*s*. 6*d*. net.

The Calendar: Its History, Structure, and Improvement. By Alexander Philip. Pp. xii+104. (Cambridge: At the University Press.) 7*s*. 6*d*. net.

Benign Stupors: A Study of a New Mania—Depressive Reaction Type. By Dr. A. Hoch. Pp. xii+284. (Cambridge: At the University Press.) 14*s*. net.

The Provinces of Ireland. Edited by George Fletcher. Munster. Pp. xii+176. Ulster. Pp. xii+186. (Cambridge: At the University Press.) 6*s*. 6*d*. net each.

Town Theory and Practice. By W. R. Lethaby and others. Pp. 139. (London: Benn Bros., Ltd.) 5*s*. net.

Four-Figure Logarithms and other Tables. By G. Hogben. New edition. Pp. 24. (Auckland, N.Z., and London: Whitcombe and Tombs.) 2*s*. 6*d*.

Précis de Physiologie Végétale. By Prof. L. Maquenne. (Collection Payot.) Pp. 175. (Paris: Payot et Cie.) 4 francs.

Forestry for Woodmen. By C. O. Hanson. Second edition. Pp. 238+13 plates. (Oxford: Clarendon Press.)

Synthetic Tannins: Their Synthesis, Industrial Production and Application. By Dr. Georg Grasser. Translated by F. G. A. Enna. Pp. viii+143. (London: Crosby Lockwood and Son.) 12*s*. net.

The Adjustment and Testing of Telescope Objectives. Third edition. Pp. 123+3 plates. (York and London: T. Cooke and Sons, Ltd.)

The Palace of Minos: A Comparative Account of the Successive Stages of the Early Cretan Civilization as Illustrated by the Discoveries at Knossos. By

Sir Arthur Evans. Vol. 1: The Neolithic and Early and Middle Minoan Ages. Pp. xxiv+721+18 plates. (London: Macmillan and Co., Ltd.) 6 guineas net.

Medical Research Council. Reports of the Industrial Fatigue Research Board. No. 12: Vocational Guidance. (A Review of the Literature.) By B. Muscio. (General Series, No. 4.) Pp. 57. 1s. net. No. 15: Motion Study in Metal Polishing. By E. Farmer and R. S. Brooke. (Metal Series, No. 5.) Pp. 65. 2s. net. (London: H.M. Stationery Office.)

Imperial Institute Map of the Chief Sources of Metals in the British Empire, with Diagrams of Production. Prepared under the direction of the Mineral Resources Committee of the Imperial Institute. $35\frac{1}{2}'' \times 44''$. (London: G. Philip and Son, Ltd.) 5s. 6d. net.

Tierpsychologie. By Prof. Dr. H. E. Ziegler. (Sammlung Göschen 824.) Pp. 115. (Berlin and Leipzig: W. de Gruyter and Co.) 6 marks.

The University of Chicago: Publications of the Yerkes Observatory. Vol. 3, Part 3: The Rotation Period of the Sun as Determined from Measures of Plates taken with the Rumford Spectroheliograph. By Philip Fox. Pp. viii+67–204+plates 24–26. (Chicago: University of Chicago Press; London: Cambridge University Press.) 2.50 dollars net.

Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia. Verhandelingen No. 7: On the Distribution of Earthquakes in the Netherlands East Indian Archipelago, 1909–1919; with a Discussion of Time Tables. By Dr. S. W. Wisser. Pp. iv+79+3 plates. Verhandelingen No. 8: Het Klimaat van Nederlandsch Indië. (The Climate of the Netherlands Indies.) Deel 1 (Vol. 1): Algemeene Hoofdstukken (General Chapters), Aflevering 1 (Part 1) (With English Summaries). By Dr. C. Braak. Pp. viii+64+18. (Batavia.)

Department of Scientific and Industrial Research. Bulletin No. 5: The Cleaning and Restoration of Museum Exhibits. Report upon Investigations conducted at the British Museum. Pp. 12. (London: H.M. Stationery Office.) 2s. net.

Department of Scientific and Industrial Research: Fuel Research Board. Technical Paper No. 3: The Efficiency of Low Temperature Coke in Domestic Appliances. By Dr. M. W. Fishenden. Pp. 35. (London: H.M. Stationery Office.) 9d. net.

Out West for Thirty Years: Notes of a Ministry in the Real Australia. By the Rev. W. Robertson. Pp. x+191. (The Manse, Hay, N.S.W.: The Author.) 2s.

Die Rätzel des Vogelzuges: Ihre Lösung auf Experimentellem Wege durch Aeronautik, Aviatik und Vogelberingung. By F. von Lucanus. Pp. viii+226. (Langensalza: H. Beyer und Sohne.) 30 marks.

The British Journal Photographic Almanac and Photographer's Daily Companion, 1922. Edited by G. E. Brown. 61st issue. Pp. 820. (London: H. Greenwood and Co., Ltd.) 2s. net.

Catalogue of the Selous Collection of Big Game in the British Museum (Natural History). By J. G. Dollman. Pp. viii+112. (London: Longmans, Green and Co.) 7s. 6d.

Thought-Coin. By Bart Kennedy. Pp. x+219. (London: W. Rider and Son, Ltd.) 5s. net.

Main Counts and Calculations. By T. Woodhouse. (Oxford Technical Manuals.) Pp. viii+119. (London: H. Frowde and Hodder and Stoughton.) 6s. net.

Transactions of the Royal Society of Edinburgh. Vol. 52, Part 4 (No. 33): On Old Red Sandstone Plants showing Structure, from the Rhynie Chert Bed, Aberdeenshire. Part 5: The Thallophyta Occurring in the Peat-Bed, the Succession of the Plants throughout a Vertical Section of the Bed, and the Conditions of Accumulation and Preservation of the Deposit. By Dr. R. Kidston and Dr. W. H. Lang. Pp. 855–902+10 plates. (Edinburgh: R. Grant and Son; London: Williams and Norgate.) 13s.

The Economic Aspects of Geology. By C. K. Leith. Pp. xvi+457. (London: Constable and Co., Ltd.) 18s.

A Treatise of Electro-Chemistry. Edited by B. Blount. The Electro-Metallurgy of Steel. By C. C. Gow. Pp. xvi+351. (London: Constable and Co., Ltd.) 27s. 6d.

The Legacy of Greece. Edited by R. W. Livingstone. Pp. xii+424. (Oxford: Clarendon Press.) 7s. 6d. net.

Diary of Societies.

THURSDAY, DECEMBER 29.

ROYAL INSTITUTION, at 3.—Prof. J. A. Fleming: Electric Waves and Wireless Telephony: Surface Waves on Liquids.

INSTITUTION OF AUTOMOBILE ENGINEERS (at 28 Victoria Street), at 7.30.—Adjourned Discussion on Paper by H. F. L. Orcutt: Motor-car Gear-boxes.

SATURDAY, DECEMBER 31.

ROYAL INSTITUTION, at 3.—Prof. J. A. Fleming: Electric Waves and Wireless Telephony: Waves in Air.

CONTENTS

PAGE

Carbon Monoxide in Public Gas Supplies. By W. A. B. . . . 521
Diseases of the Rubber Tree (*Hevea braziliensis*) By J. B. F. . . . 524
Some Psychological "As Ifs." By C. Ll. M. . . . 525
Our Bookshelf . . . 526
Letters to the Editor:—
The Tendency of Elongated Bodies to Set in the East and West Direction.—Walter D. Lambert . . 528
Japanese Culture Pearls.—Dr. H. Lyster Jameson 528
A Curious Physiological Phenomenon. — F. C. Dannatt; Prof. T. Graham Brown . . 529
Echinoderm Larvæ and their Bearing on Classification.—Prof. E. W. MacBride, F.R.S.; Dr. F. A. Bather, F.R.S. . . . 529
Some Problems in Evolution.—W. R. Bousfield, K.C., F.R.S.; Prof. E. S. Goodrich, F.R.S. 530
World List of Scientific Periodicals.—Prof. W. W. Watts, F.R.S. . . . 531
Old Observations Bearing on the Duration of Sunrise.—Dr. Willard J. Fisher . . . 531
The Measurement of Ionisation Currents by Three-electrode Valves. (*With Diagram.*)—J. C. M. Brentano . . . 532
Simple Sensitive Flames.—G. A. Sutherland . . . 532
The Message of Science. By Sir Richard Gregory 533
Integration in the Living Organism. By Prof. W. M. Bayliss, F.R.S. . . . 537
"Leader" Cables for Aircraft . . . 539
War Work of the Bureau of Standards, U.S.A. By J. L. H. . . . 540
Obituary:—
The Right Hon. Lord Lindley, P.C., F.R.S. 541
Notes . . . 542
Our Astronomical Column:—
The Markings on Jupiter . . . 547
The Ultra-Violet Spectrum of α Cygni . . . 547
The Origin of the Scottish People . . . 548
An Agricultural Enterprise . . . 549
Optical Wedges. By C. J. . . . 550
The South African Association for the Advancement of Science. By H. B. F. . . . 550
University and Educational Intelligence . . . 552
Calendar of Scientific Pioneers . . . 553
Societies and Academies . . . 554
Books Received . . . 555
Diary of Societies . . . 556

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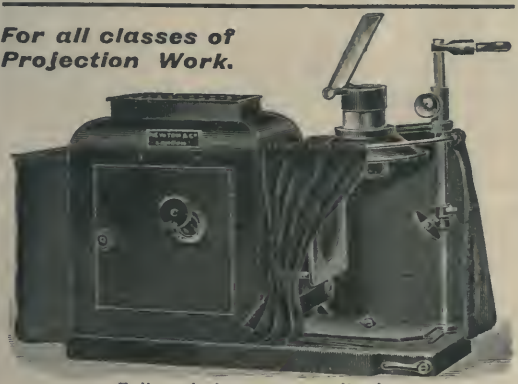

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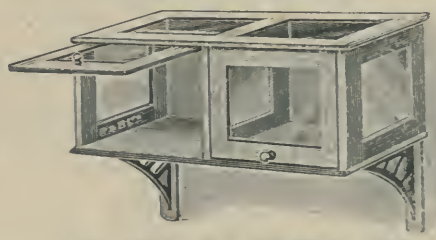

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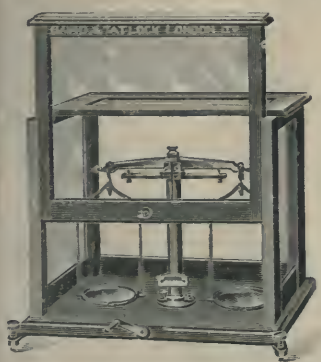

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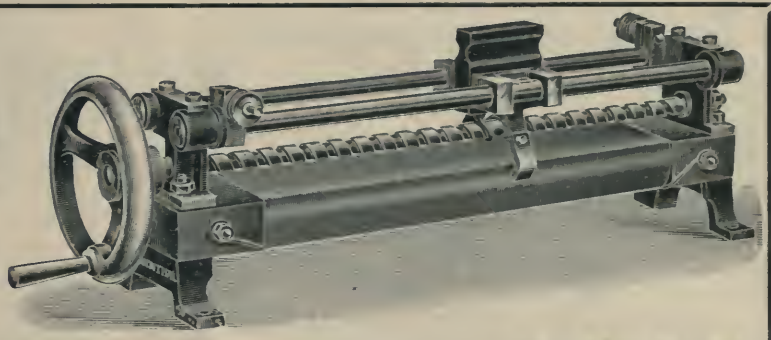

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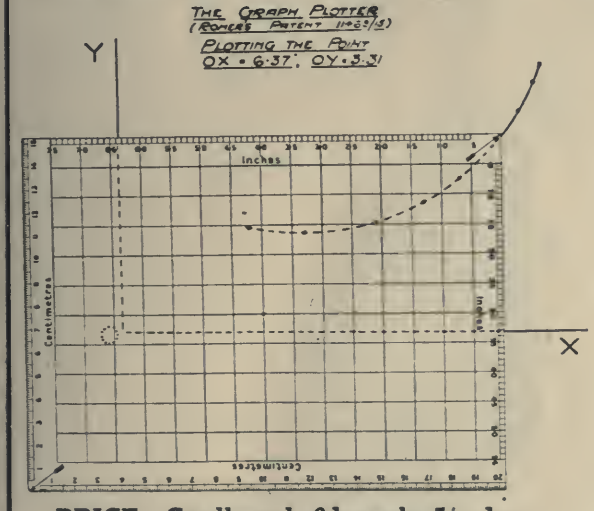

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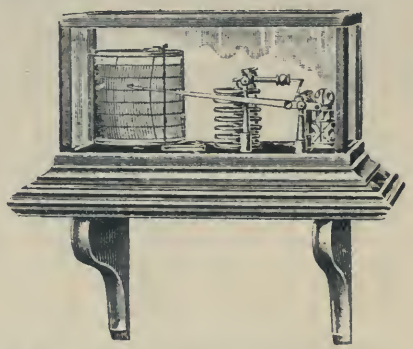

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Smoke Abatement.[1]

THE final report of Lord Newton's Committee on Smoke and Noxious Vapours Abatement, appointed nearly two years ago by the Minister of Health, makes its appearance at an opportune time. The conditions affecting the supply and distribution of coal are gradually becoming more normal, and we are looking forward to the time when its consumption will more nearly accord with the country's needs. The recent disturbance in the coal trade and the absolute futility of the wasteful strike have taught us many lessons which it would be the height of unwisdom not to lay to heart. We have learned, for example, the imperative necessity for more economy in the consumption of our coal. There is a wider recognition of the fact that our methods of using it as fuel are extravagant and wasteful, and that we get no adequate return of its potential value. We have realised that heat and power are bound, for at least some years to come, to cost us more than they did in pre-war years. This question affects everybody; it is, in fact, at the root of the country's well-being and prosperity. We ought, therefore, to see that all possible means are taken to ensure that in its use we get the value of our coal. It is notorious that under our present systems we get only a fraction of that value. It is not too much to say that if the country's fuel were treated in accordance with the teaching of science its present high price would be largely, if not wholly, counterbalanced.

Another lesson which the recent scarcity of coal brought home to the dwellers in our towns is the delight and the blessing of a pure atmosphere. During the coal strike the public Press literally teemed with expressions of pleasure and gratification in the enjoyment of a cleaner and clearer air. London enjoyed vistas hitherto unperceived, and Manchester, Leeds, and Sheffield had the unwonted luxury of an uninterrupted view of the heavens and the sight of a distant landscape. The man in the street naturally asked himself whether, with the anticipated return of prosperity, it was absolutely necessary that we should revert to the former condition of things. Interested parties are apt to preach that a smoky atmosphere is an index of the country's industrial activity. Undoubtedly it has been so in the past. But the conditions of to-day are not those of even a dozen years ago. Science has pointed to much in the way of amelioration, and there is absolutely no reason why the charm and healthful pleasure of a clear atmosphere should not continue to be enjoyed, not only in London, but even in the busiest of our manufacturing towns, if public opinion were resolute to secure it.

The Report of Lord Newton's Committee, admirable as it is in many respects, affords no fresh information to those who have studied this question of smoke, its cause, and the methods of its abatement. The evil has been with us since the time of Edward I., and has steadily increased with the growth of our population and the development of our manufacturing industries. It has probably already passed its worst phase. Economic influences are at work tending to mitigate it. Legislation has made, from time to time, feeble attempts to deal with the nuisance, but Governments, afraid of any interference with industry, have been loth to attack the problem in a statesmanlike fashion, and municipal authorities, with whom the administration of the law rests, for reasons which need not be particularly specified, have been even more reluctant to take action. The consequence is that England has the smokiest and smuttiest atmosphere, taking it as a whole, of any country in the world. The condition of many of the smoke-begrimed towns in the manufacturing districts of Lancashire, Yorkshire, and Staffordshire is a disgrace to a civilised community.

The Committee frames a strong indictment against local authorities throughout the country who have failed to do their duty. In its opinion the provisions of the existing law are strong enough to combat the evil if they were only enforced. It must be said, however, in bare justice to these authorities, that certain of these provisions make it very difficult

[1] Committee on Smoke and Noxious Vapours Abatement. Final Report. (London: H.M. Stationery Office, 1921.) 6*d*. net.

to secure the conviction of offenders. The indictable offence consists in the emission of *black* smoke. Two policemen acting on behalf of the prosecution —that is, the sanitary authority—may swear that in their opinion the smoke was black; three civilians, on behalf of the defence, will swear that in their judgment it was grey. Again, if the offender can satisfy the bench that he has employed the best practicable means, consistently with carrying on his industry, to abate it, he is exculpated. It is inevitable that there should be a conflict of testimony as to what, in such circumstances, are "the best practicable means." It is equally inevitable also that magistrates, local J.P.'s for the most part and swayed by local influences, should be slow to convict. The sanitary authority finds itself powerless, and further action is estopped. The Committee is fully alive to these difficulties and blames the central authority.

"The chief factor," it says, "in the failure to deal with the smoke evil has been the inaction of the central authority. No Government has, for many years, taken any action with the exception of appointing committees, whose labours have led to little or no result. Smoke and air pollution are, in our opinion, a national question, and we consider that it is useless to expect that it will be adequately dealt with by local authorities unless they are subject, when necessary, to the stimulus of Government. It is for this reason that we recommend that defaulting authorities should be compelled to act by the Minister of Health."

The prevalence of smoke pollution in this country is mainly due to the indiscriminate and wasteful use of *raw* coal for all purposes, whether industrial or domestic. Such is the finding of the Committee. This is already acknowledged by everyone who has devoted any attention to the question of smoke abatement. The problem of so treating coal as to render its combustion practically smokeless is at present the main effort of the Fuel Research Board acting under the direction of the Department of Scientific and Industrial Research. As an economic question the problem admittedly has its complexities. There is no difficulty in coking or semi-coking coal so that it shall burn with a smokeless flame, *at a price*, depending upon the value of—that is, the market for—the by-products of the coking. Hitherto the efforts to introduce such smokeless fuel have not been economically sound, or at least have failed in view of present conditions. Whether the efforts of the Fuel Research Board will solve the problem remains to be seen. It cannot be doubted that the Board's experimental investigations will afford valuable data towards its solution. Such investigations require time, and it is not improbable that Government may take advantage of that fact to delay any further action with regard to legislation on smoke abatement. There is, however, no real reason why the Ministry of Health should decline to act at once on the recommendations of Lord Newton's Committee. The amending legislation required would be comparatively slight, and its passage through Parliament, in view of what the Committee recognises as the strong body of educated opinion which is extremely dissatisfied with present conditions, should offer no insuperable difficulties.

The recommendations are divided under two heads: (1) with regard to industrial smoke; (2) with regard to domestic smoke. As regards industrial smoke, the obligation to use "the best practicable means" to abate it must still devolve upon the occupiers of any business premises, the onus of proof that such means are the best practicable to rest upon the manufacturer. The duty of enforcing the law should be transferred from the local sanitary authorities to the county authorities —*i.e.* to Councils of counties and county boroughs. The Minister of Health should appoint competent officers to advise and assist local authorities and manufacturers with regard to difficult smoke problems, these officers to report annually on the steps taken and the progress made in the suppression of avoidable smoke. This recommendation is obviously based upon the Committee's knowledge of the operation of the Alkali, etc., Works Regulation Act, which has admittedly worked successfully and with no great friction or hindrance to the industries concerned. Lastly, as regards industrial smoke the Committee recommends that the law should enable much larger fines to be imposed than at present. Experience has shown that "the fines at present inflicted are too trivial to be an effective deterrent, manufacturers in many instances preferring to pay the fine rather than take the necessary steps to abate the nuisance."

As regards domestic smoke the Committee recommends that the Central Housing Authority should, at their discretion, decline to sanction any housing scheme unless specific provision is made in the plans for the adoption of smokeless methods of heating, and that local authorities should make by-laws requiring the provision of smokeless heating arrangements in new buildings, such as hotels, clubs, offices, and the like. It further recommends that Government should encourage the co-ordination and extension of research into domestic heating generally, and that every encouragement and facility should be given to gas and electricity undertakings to increase and cheapen the supply of gas and electricity, and that

the practice at present followed by some municipal authorities of over-charging for gas and electricity in order to relieve the rates should be discontinued.

Certain of the Committee's recommendations are, it must be confessed, rather in the nature of counsels of perfection, but the Report is, on the whole, a business-like document, and the Committee's proposals are, as it says, "prosaic but practical." The Report is unanimous and commendably short and to the point. As the latest word on the important question with which it deals, it is well worthy of the attention and consideration of all interested in the pressing problem of smoke abatement.

Christian Theism.

Studies in Christian Philosophy, being the Boyle Lectures, 1920. By the Rev. Prof. W. R. Matthews. Pp. xiv+231. (London: Macmillan and Co., Ltd., 1921.) 12*s*. net.

THIS book may be commended to the notice of such as wish to know what can be said by a theologian possessing the broad outlook of the philosopher, and equipped with a knowledge of recent philosophical literature, as to the intellectual claims of Christian theism; it represents a good type of the kind of justification of theistic belief with which a Christian would desire thoughtful inquirers to be acquainted. It does not profess to break new ground, and, save for reflections on minor points, it does not offer critical or constructive contributions such as have not in essence been made before; but it is characterised by ability in a degree sufficient to engender curiosity as to its possible sequels, at which its author hints. If, in a later volume, the author intends to deal with the Christological problem on lines suggested by his remark (p. 54) that Christian theology has often treated the relation of Jesus to the Father "as a puzzle in ontology rather than a moral fact," his future readers will be interested to see how he will avoid the ontological issue, and how, in emphasising the moral aspect of the relation in question, he will evade difficulties in connection with theodicy. Another *obiter dictum* (p. 164) concerning the reconcilability of the tritheistic and the modalistic or unitarian interpretations of the doctrine of the Trinity arouses a similar curiosity; and if the author's hope of effecting such a reconciliation be based on his objection (p. 226) to the distinction between adjectival and substantival existence as a misleading one, it may be worth while to point out to him beforehand that the objection which he has urged does not apply to the real distinction, without which logic would become impossible, but only to a perverse misrepresentation or obliteration of it.

But, to speak of the present work itself, the lectures deal with such subjects as the Christian view of the world, ethical theism, the moral argument, and the ideas of personality and creation; and their main purpose is to show that, among the various forthcoming endeavours of philosophy to explain or interpret the world and man, Christian theism is not only a "live option," but is also intellectually the most satisfactory—the best inductive hypothesis. With this main position, and with the conclusions of all (save one) of the author's lectures, I am in too close agreement, in the main, to be a useful critic; but, inasmuch as expression of criticism or of difference of opinion is what a writer chiefly hopes for from a reviewer, I may the less reluctantly confine myself, in the remainder of this notice, to the chapter on the moral argument for theism.

This chapter, the most brightly written in the bright and lucid volume, is to me unconvincing. Fully to explain why would involve a general discussion of the whole theory of value; consequently I must risk being but imperfectly intelligible to my readers until they also have become readers of Mr. Matthews's book in taking for consideration here a few of his contentions as they stand, and in isolation from the general theory which they presuppose.

First, though one may agree with his proof that naturalistic ethic is absurd, and that the authority of moral judgments cannot be explained in terms of their survival-value, or as a matter of man's relation to his physical environment, one may dispute that theism is then directly thrust upon us as the only alternative. Man's environment includes humanity, and the capacity for thought which may be a result of adaptation to environment, once acquired, can thenceforward be applied to matters of the non-utilitarian kind. Man's morality, the exposition of which is but theoretic judgments on facts pertaining to the practical or conative side of human experience, thus calls no more for the direct invocation of a *Deus ex machina*, or of a *Logos endiathetos*, than does man's mathematical science. The same applies to man's moral progress. Pluralism, which Mr. Matthews here rules out, as it seems to me, for an irrelevant reason, may hardly account for such moral harmony as we find, and may promise no ultimate achievement of the highest good; but that it is irreconcilable with such knowledge as we have concerning moral

ideals is no more obvious than is its irreconcilability with the existence of pure mathematics.

Secondly, one may dispute the limitation, which Mr. Matthews would thrust upon us, to a choice between mere individual taste-preferences, on one hand, and absolute moral standards independent of *all* human minds, on the other. The objectivity of moral judgments, like the objectivity of physical objects and their relations, may mean simply their "commonness" or universality, and this is not to be assumed identical with their existence *per se*; the over-individual is not necessarily the over-social or the absolute, and, therefore, does not directly imply the theistic postulate. To show that morality is independent of the lower or the sub-personal preferences of the individual is not to show that it is independent of the socially developed conative experience of the race. Universal experience is but an elaboration of the individual experience which it presupposes, whether on the ethical or the scientific side.

Thirdly, it would save confusion if, instead of speaking of the "existence" of moral ideals, which savours of the ontological fallacy, we spoke of their validity. Ideals "exist" only as ideas in minds—as Mr. Matthews in one place admits. And absolute norms, perfect ideals, like all limiting-concepts, whether in mathematics or in ethics, have, in so far as their existence is concerned, precisely the same ontological status as relative norms. There seems to be no more need to invoke a theistic origin for them than for the other kind.

Fourthly, though the concept of moral progress may presuppose a concept of an end, and the concept of a moral end or a highest good may presuppose the concept of its attainability, it does not follow that actual progress may not be effected by humanity's possession of an idea of a relatively better state, or without any sanguine hope that mankind will ever achieve a perfect moral condition. Hence the argument that the *fact* of moral progress in the race implies the truth of theism (which resembles in form the Kantian argument for human immortality), like all direct arguments from morality to theism, seems to me to involve a fallacy. Theism is rather to be presented as the best interpretation of our knowledge and experience as a whole, and its strength lies in its cumulativeness; but morality alone cannot conclusively justify the belief.

Lastly, the author's moral argument, as a whole, seems to me to be vitiated by his apparently unconscious use of the ambiguous word "rationality" in three different senses. The only rationality—as predicated of the world—of which we have knowledge, and which can therefore form the major premiss in an argument to theism from human needs or aspirations, is the partial "intelligibility" of the world by our analytic understanding. I say "partial," because wholly amenable to such understanding, and to the deductiveness at which theoretical science aims, the world (in spite of Mr. Matthews's apparent belief or hope to the contrary) certainly is not. There is the essentially alogical element of brute fact, of sensible quality, of physical constants, which science, while ever disregarding it in her search for deductiveness and for identity, implicitly recognises in her empirical procedure. In one or two passages (*e.g.* p. 154) Mr. Matthews explicitly uses "rational" in this sense of "intelligible." But this sense is quite distinct from, and it by no means implies, either the second meaning (that which is generally before the writer's mind in this chapter) of "teleologically ordered," or the third (which is always in the background of his thought, and peeps out, *e.g.* on p. 117), in which "rational" becomes synonymous with "reasonable," or with "satisfying" man's hopes or aspirations. In consequence of a surreptitious interchange of these diverse meanings of "rationality," Mr. Matthews's argument may appear plausible; but in strict logic it only establishes the tautology that if the world be teleologically ordered, theism is true.

F. R. TENNANT.

Domestic Heating and Waste of Coal and Health.

Domestic Fuel Consumption. By A. H. Barker. (The Chadwick Library.) Pp. x+159. (London: Constable and Co., Ltd., 1920.) 14*s.* net.

ONE of the most important domestic questions which faces the Government is the conservation of coal, and at the same time of health, by the cleansing of the skies and cities from soot. A nation of sun worshippers would not have fouled its dwellings as the worshippers of Mammon in our cities have done. The waste of coal hitherto has been colossal. Prof. W. A. Bone estimated that no less than 95 per cent. of the thermal energy of coal is wasted in power production, and Mr. A. H. Barker, in his Chadwick lectures on "Domestic Fuel Consumption," now published in book form, estimates that of the fuel used for domestic service, of the yearly value of 50,000,000*l.*, at least three-quarters is wasted, partly through ignorance and carelessness, and partly through defects in the design of the plant employed. A person who is wasting water and food can see these going to waste, but he, or she, cannot see heat running away, and so no effort is made for economy.

The economic difficulty of providing efficient apparatus in place of the jerry-built stoves, ignorantly designed with a view to cheapness of primary cost and superficial appearance, impels the poor to be chief offenders and sufferers through no fault of their own, while the rich man can afford to buy, and has space to fix, economical fittings. He also, as Mr. Barker says, has the intelligence, or can purchase it, to use these properly and prevent the even greater waste of fuel which results from the careless or ignorant use of such fittings. Thus the nation's wealth of coal, which should be conserved or used for export and barter, is wasted, and the sky is fouled with smoke, cities and persons are made unclean, buildings corroded, decorations, furniture, and clothing spoilt, a vast amount of human energy wasted in cleaning, painting, etc., the transit of goods and people is impeded by fog, with consequent very great economic loss, energy wasted in needless artificial illumination, vegetation stunted or destroyed, and people in cities are thus deprived of green food, salads, etc., which might be grown in back gardens and allotments—foods, by the way, which are the great natural store of the essential growth and health principles: the vitamins. Owing to the smoke pall, people are impelled also by the gloom of their surroundings from outdoor exercise to indoor pursuits, with consequent deterioration of health and stamina. A life spent in stagnant air within doors, with its low cooling and evaporative power, depresses the body heat production, lessens appetite, makes the breathing shallow, enfeebles the circulation, leads to derangements of the bowels and constipation, to loss of muscular tone and vigour, and makes pale, weakly, and unhappy citizens.

The reviewer is writing these sentences in November at Montana-sur-Sierre in Switzerland at an altitude of 5000 ft. where the sun is shining some eight hours a day, although it is freezing in the shade, and the air is almost calm and very dry. While the surface temperature of his coat is, in the sun, 40–50° C., the cooling and evaporative power of the air exerted on the skin is high; so, too, on the respiratory membrane. On the surface of the dry kata-thermometer at body temperature the cooling power averages 15–20 millicalories per sq. cm. per sec., while the evaporative power, measured by the difference between the dry and wet kata-thermometer, averages about 20 millicalories per sq. cm. per sec.; the surface temperature of the cheek exposed to such conditions is about 25° C. To these conditions children with tubercular disease of the joints or spine are exposed, splinted and nude, on their beds, and, bathed by sun and cool, dry air, do wonderfully well. Their body heat production is sent up some 100 per cent. above that of children clothed and resting in a chamber. On the other hand the cooling power in ordinary rooms and workshops in England, called fresh, is 5–6, as measured by the dry kata-thermometer, the evaporative power 10–12, and the cheek temperature about 33° C. There is in such rooms, heated by hot water or steam coil, no source of radiant energy to warm the surface of the clothes as the sun at Montana warms these to 40–50° C.; it is the sun which makes comfortable the high cooling and stimulating power of the Alpine air.

Children become consumptive and rickety in tenement dwellings through the want of vitamins and other essential food principles and the confinement which depresses their metabolism. They are then sent to be cured at expensive sanatoria by open-air treatment and good food. How wasteful it is for a Government to let them become diseased, how absurd to educate the still healthy young in confined school-rooms, when open-air treatment is proved to restore the unhealthy to good health. By coal conservation and the use of smokeless fuel, gas, etc., not only can the skies be cleaned and our proper share of sunshine obtained, but green foods can be grown and eaten and open-air exercise taken by many more than at present. Such a reform, together with the extension of smokeless factory garden cities, are the great aims of preventive medicine; such measures, together with wise control of breeding, may prevent, or at any rate delay, the nation becoming worn out as past empires, as communities of ants in ant-hills, become worn out by overcrowding.

Mr. Barker's book will be of use to all those who wish to choose heating and lighting appliances and run these with economy. He points out that to use electricity generated from coal for heating and cooking is unjustifiable when the saving of money and fuel are paramount considerations, for only some 8 per cent. of the thermal energy of the coal is converted into electricity at the power stations, and the rest is wasted. Electricity generated from water-power otherwise running to waste is, on the other hand, the most convenient and economical source of heat.

"Hot water can be supplied by burning solid fuel in a suitable apparatus very economically." "One ton of fuel used in an ordinary range will supply as much hot water as 20,000 cubic feet of gas in an ordinary gas boiler at about two-

thirds of the cost," and the range is, at the same time, available for cooking. "Gas has its advantages when small quantities of hot water are generated where and when required." "By far the greater part of the waste of fuel used for a hot-water supply is due to loss of heat from uncoated pipes and tanks. Four-fifths of the fuel used may be saved by the use of good non-conductors." "The cost of continuous warming by coal as against gas fires is about one-third or one-quarter, but gas is far the more convenient and economical when a living-room is only occasionally used and required to be ready for occupation in a short time"; moreover, the use of gas fires or other smokeless fuel conserves coal and cleans the skies. In the matter of lighting, Mr. Barker points out the economy of using for passages or as a night-light a lamp of higher voltage than that in the mains. "The use of a 200 volt lamp on a 50 volt circuit would give a night-light probably at about one-twentieth the cost of a paraffin-wax night-light."

Such quotations suffice to show the practical suggestions put in simple and clear language, of which the book is full. In dealing with ventilation and heating in connection with comfort and health—that is, with physiological principles—the author evokes, as so many do, some mysterious influence in addition to the physical qualities of the air. Without adducing a particle of evidence, he writes of "something probably in the nature of ionisation or deionisation or variation of potential." He considers the view that sensations of stuffiness are dependent on temperature and humidity (movement must be added) as "totally inadequate." Well, let him compare the physical conditions of Montana out of doors with those in the room in London best ventilated and warmed by his own methods. L. H.

Metallurgical Principles and Processes.

(1) *The Physical Chemistry of the Metals.* By Prof. R. Schenck. Translated and annotated by R. S. Dean. Pp. viii+239. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) 22*s.* 6*d.* net.

(2) *Electric Furnaces in the Iron and Steel Industry.* By W. Rodenhauser, J. Schoenawa, and C. H. Vom Baur. Translated from the original by the latter, and now completely rewritten. Third edition, revised. Pp. xxi+460. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) 24*s.* net.

(1) PROF. SCHENCK'S course of lectures, delivered to an audience of technical men at Aachen, was first published in 1909, and at once proved of great service to teachers of metallurgy and to students desirous of acquiring an insight into the scientific principles underlying metallurgical processes. At the same time, it directed the attention of physical chemists to the large mass of intrinsically interesting material for the study of chemical reactions and equilibria which is available from metallurgical sources. The subjects of the lectures were:—The properties of metals; metallic solutions and alloys; carbides, oxides, sulphides, and mattes; the processes of oxidation and reduction; blast-furnace reactions; and the reactions of sulphides. Of these the subject of the constitution and structure of alloys has been treated by many writers, and text-books of metallography are numerous, but the kindred studies of mattes and slags, and of roasting and smelting reactions, have received far less attention. There is, therefore, room for such a work, and a translation is to be welcomed.

In view of the time that has elapsed since the delivery of the original lectures, however, it would have been advisable to subject the text to thorough revision, as many advances have been made in the meantime. A few later data have been incorporated, but the alterations are trivial. The most interesting sections are those concerned with mattes and similar mixtures and with the blast-furnace reactions. These sections will repay study by physical chemists as well as by metallurgists on account of the interest presented by the equilibria involved. It is difficult to obtain absolutely satisfactory data, as the reactions are often slow, especially when solid phases are concerned, and some of the investigations in this field have had to be repeated with additional precautions. The value of the work to the metallurgist would have been increased by the inclusion of a section dealing with silicates, on account of the importance of the slag in most smelting processes. The presence of a liquid mixture of silicates, in which metallic oxides can dissolve, is an essential condition of many operations, both in the ferrous and the non-ferrous industries, and the changes of the slag in an open-hearth steel furnace during the working of the charge, or the relations between the compositions of the slag and the matte in copper smelting, for instance, furnish examples of equilibria which are as interesting theoretically as they are important in practice.

The translation is unfortunately marred by many inaccuracies. Apart from the very numerous and irritating misspellings of proper names the sense of the original is often missed, especially in the section dealing with the electron theory of metals. A revision of this section has been designedly excluded on the ground that the subject deserves a separate treatise, but it would have been well to omit the subject altogether or to revise it in the

light of later work. Students who wish to learn something of the nature of metallography without studying one of the larger works will find a simple account of the subject in the second and third chapters, illustrated by excellent photomicrographs from standard works, but references to original sources are throughout irregular and imperfect.

(2) The well-known treatise on electric steel furnaces by Rodenhauser and Schoenawa has now reached a third edition and has been completely revised by the authors and the translator. During the stress of the war period there was a remarkable increase in the number of electric furnaces employed in the steel industry, but the results obtained have been varied. Opinions strongly in favour of—and others as strongly unfavourable towards—the electric furnace are held by different technical experts. The reason for this diversity appears to be that in many cases the furnace has been improperly handled. A steel smelter who is ignorant of electrical engineering, or an electrical engineer who has little or no acquaintance with the metallurgy of steel, is unlikely to obtain success with this method of manufacture. Where the right combination of engineering with metallurgical knowledge and experience is found, the electric furnace gives most favourable results. The perfect control over the melting conditions which it allows is greatly in its favour, especially when steels containing costly alloy metals are concerned, and its position in the steel industry is assured. This is true even of countries where fuel is abundant, but the advantages are still greater in those countries where water power is available and fuel scarce. This gives importance to the electric blast-furnace, an appliance which can scarcely compete with the highly efficient blast-furnace on its own ground, but which may prove the salvation of iron-ore producing countries which have no coal.

The present work is written mainly from the electrical point of view, and is very full in its treatment of the electrical conditions of construction and working. The metallurgical working is comparatively lightly touched on; in fact, the chemistry of electric steel making still awaits textbook treatment. As might be expected from the associations of the authors, the induction furnace is given greater prominence than is usual in other works on the subject, and the discussion of this type is very full. The Röchling-Rodenhauser furnace is now in use in 20-ton sizes, a remarkably large capacity for this class, while it is maintained that induction furnaces may be used successfully for the refining of steel, although the question of the relatively cold slag is not fully dealt with. The work refers mainly to German and American practice, and the types of furnace most largely employed in this country are rather briefly discussed. The consideration of the electrical conditions and of the thermal balance is very thorough, and many records of actual runs are included. English readers will also be glad to have the detailed account of iron-ore smelting in Sweden and elsewhere, illustrated by clear diagrams and numerical records. An interesting account of experiments on the reduction of ore (a fine magnetite high in sulphur) by means of sulphurous coke breeze in the Röchling-Rodenhauser furnace is given, liquid metal from a basic Bessemer converter being used to start the charge. A good efficiency was obtained and about half the sulphur was eliminated without the use of lime. Minor criticisms are, of course, possible, but metallurgists who are considering the advantages of this method of manufacture will find the book indispensable.

C. H. DESCH.

Our Bookshelf.

The Year-Book of the Scientific and Learned Societies of Great Britain and Ireland. Compiled from official sources. Thirty-eighth annual issue. Pp. viii+366. (London: C. Griffin and Co., Ltd., 1921.) 15*s.* net.

WE are glad to extend a welcome to the new issue of this invaluable year-book. The system adopted in previous issues of classifying the societies according to the subjects with which they are concerned is adhered to, and a few pages are devoted to miscellaneous societies particulars of which were received too late for classification.

We notice that, of the twenty-six Research Associations referred to in NATURE of December 15, p. 489, which have been approved by the Department of Scientific and Industrial Research, one only—and that, one of those more recently constituted—namely, the British Cast Iron Research Association, appears to have been included. We have also been unable to find any mention of the Association of Economic Biologists. In spite of these omissions the year-book is an indispensable adjunct to every library, society, and similar institution the members of which require accurate official particulars of the learned societies of the British Isles. The publishers perform a national service by providing this annual conspectus of scientific organisations and their work.

Le Mouvement Biologique en Europe. By Georges Bohn. Pp. 144. (Paris: Armand Colin, 1921.) 4 francs.

DURING the summer and autumn of 1913 the author of this pamphlet visited the most active

centres of biological research in Austria-Hungary, Russia, and Germany; he now sets forth, not only an epitome of the work that was then in progress at the several laboratories, but also his meditations on the effects produced by political circumstances upon the scientific spirit and scientific output of the respective nations. The general tenor of his views, which are deserving of most careful attention, may be gathered from the following quotations: "Les Allemands avaient voulu organiser une université grandiose à Strasbourg, mais, malgré des installations somptueuses et des crédits considérables, la vie scientifique était loin d'y avoir les mêmes manifestations brillantes qu'à Cracovie, où la domination autrichienne était moins pesante et où l'âme nationale pouvait encore s'extérioriser." "Les régimes politiques basés sur la liberté se sont toujours montrés favorables au développement des sciences et des arts. Si la discipline renforce l'esprit de logique, elle tue au contraire l'esprit d'invention." The book should be studied and digested by politicians as well as by men of science, and especially by those who are concerned with the organisation of education.

Practical Geometry for Builders and Architects. By J. E. Paynter. (*The Directly-useful Technical Series.*) Pp. xii+409. (London: Chapman and Hall, Ltd., 1921.) 15*s.* net.

In compiling this book it has been assumed that the student is a practical man with some knowledge of the principles of geometry; hence a good deal of the more elementary work has been omitted. Among other subjects treated in the early part of the volume there are many references to surveying and surveying problems. It is almost a cause for regret that much of this matter was not also omitted, for many of the methods described would never be employed by any competent surveyor, and some could not possibly be carried out except on a sheet of drawing-paper. The author, on the other hand, is quite at home in describing the applications of geometry to problems in building construction, such as the timber of roofs, mouldings, etc., and this section of the subject, which, indeed, occupies the greater part of the volume, is excellent, and is treated in a clear, straightforward manner, which cannot fail to make the principles clear to the student.

The Electro-Deposition of Copper and its Industrial Applications. By C. W. Denny. (Pitman's Technical Primers.) Pp. xii+108. (London: Sir Isaac Pitman and Sons, Ltd., 1921.) 2*s.* 6*d.* net.

In this little manual an outline is given of modern practice in the electro-deposition of copper in its industrial applications. These include, besides the older process of electrotyping, manufacture of copper tubes, etc., a new method of making what is called reinforced copper, in which is embedded a grid or perforated plate of steel, complete automobile radiators, driving bands for projectiles, matrices for gramophone records, and several other interesting processes of recent development. Considering the limitations of space, a remarkable amount of practical detail is included.

Tidal Power. By A. M. A. Struben. (Pitman's Technical Primers.) Pp. xii+115. (London: Sir Isaac Pitman and Sons, Ltd., 1921.) 2*s.* 6*d.* net.

The idea of the development of power by utilising the tides is not new, but interest in the subject has been stimulated recently by the enunciation of the Severn scheme. The non-technical reader will find a number of modern proposals discussed in this book, together with estimates of costs, working expenses, and the probable power which may be obtained. Owing to the lack of practical experience on the large scale, a good deal of the matter presented is speculative; indeed, as the author himself states, there is ample scope for the display of originality, as this field is practically untrodden. He is right in advocating research, and we trust that there will be adequate research work done prior to the undertaking of any gigantic schemes.

Mining Physics and Chemistry. By J. W. Whitaker. With an introduction by Prof. W. H. McMillan. Pp. xii+268. (London: Edward Arnold and Co., 1921.) 9*s.* net.

Mr. Whitaker's book is an introductory account of the physics and chemistry affecting mining students. The standard is not high, but so far as it goes the account is clear and accurate. Special attention is directed to such matters as flame and oxidation, mine gases (including carbon monoxide and its physiological effects), surface and mine waters, coal, and explosives. Methods of analysis are also given. The title of Fig. 25 is incorrect.

Organic Analysis, Qualitative and Quantitative. By E. De Barry Barnett and P. C. L. Thorne. Pp. xi+168. (London: University of London Press, Ltd., 1921.) 7*s.* 6*d.*

The methods used in the detection of common organic substances, and some typical quantitative estimations, are described. Methods of determining molecular weights, and polarimetry, which are adequately dealt with in books on practical physical chemistry, might have been omitted. The authors have produced a very useful compendium for students of chemistry.

Calculations in Organic Chemistry. By Prof. V. K. Bhagwat. Pp. xi+138. (Bombay: S. Govind and Co., 1921.)

The calculations and examples collected by Prof. Bhagwat should be very useful to teachers and students, as they are of the type which regularly appear in degree examination papers. The publishers have scarcely done full justice to the author in the get-up of the book. An English edition would probably be found useful.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Accessory Nature of many Structures and Habits Associated with Courtship.

A STUDY of mating-habits in birds and other animals has led me to conclusions which perhaps have a general interest as bearing upon the whole theory of sexual selection.

As is well known, the difficulty of understanding how sexual selection could operate in monogamous animals has, together with other objections, led many naturalists to reject it wholly or almost wholly as a factor in evolution. However, whether we reject it or not, there remains a large body of observed facts which is in need of some evolutionary explanation. The facts are (1) that elaborate displays and other ceremonies occur in many animals in connection with mating, and (2) that brilliant colours and special structures are generally developed in these animals, and are employed chiefly or solely in these displays and ceremonies.

Our first and immediate conclusion is that, in view of their elaborate nature and widespread distribution, it is impossible to maintain that all these ceremonies and associated structures are biologically meaningless. Further, in many species the employment of such special structures is *invariably* associated with sexual ceremonies; for example, the ruff and ear-tufts in both sexes of *Podiceps cristatus*, the crested grebe, the elongated scapulars of egrets, or the "tail" of the male peacock. In these cases of invariable association, then, we can be sure, so far as observation alone permits certainty, that both structures and ceremonies have a biological significance in connection with mating. We can, with an almost equal approach to certainty, assign biological significance to such bright colours as are placed so as to be especially conspicuous during sexual ceremonies, *e.g.* the wing colours and markings of the blackcock and crested grebe, the brightly coloured markings on male spiders, the brilliance of the heads and necks of male birds of paradise, etc. The problem is then to discover *what* the biological significance behind these colours, structures, and ceremonies may be.

That in a large number of instances they cannot have arisen through any process of sexual selection is shown by the fact that in many monogamous birds there exist mating ceremonies, often elaborate, which occur only after pairing-up has taken place for the season. Examples of these are to be seen in the Sylviidæ (see E. Howard, "The British Warblers," 1907–14), the crested grebe (Huxley, Proc. Zool. Soc., 1914), apparently the Fringillidæ (E. Howard, "Territory in Bird Life," 1920), and in divers and egrets (unpublished observations of my own). It is obvious that sexual selection, *i.e.* selection by a female as between several potential mates, cannot operate here, since there is only one male and one female involved.

Further light is thrown on the question by the observation quoted in Pycraft's "Courtship of Animals" (Hutchinson, London, 1913) that male newts deposit their spermatophore *before* beginning their "courtship" antics. As a result of the performance, apparently, the female picks up the spermatophore with the lips of her cloaca. It is obvious here that the special ceremony and coloration of the male can be thought of only as an excitant to induce the female to perform her part in effecting the union of the gametes; if several males were to deposit their spermatophores before a single female, and then all perform their mating antics, there could be no possible agency through which a male with a particularly effective display could succeed in making the female pick up his particular spermatophore rather than another.

This conclusion is fully borne out by the experimental results of Sturtevant upon the dipteran Drosophila (quoted by Morgan, Carnegie Institution Publication No. 285, 1919, p. 61). The male of Drosophila has a mating ceremony in which he vibrates his wings in front of the female. Sturtevant showed that single males whose wings were cut off would succeed in mating when isolated with single females, but only after an average time considerably longer than that required by normal males. But when a normal male and one deprived of wings were imprisoned together in company with a single female, the wingless male succeeded in mating almost as often as his normal competitor. The so-called "courtship," therefore, is again a stimulant; once the female has been stimulated by the display she is equally ready to mate with any male, whether normal or so mutilated as to be unable to perform the "courtship" action. As Morgan says (*loc. cit.*, p. 61), "This critical test puts the problem in a different relation from that which Darwin's theory of female choice was meant to throw light on."

It appears, therefore, that in these examples—newts, Drosophila, and the post-mating ceremonies of monogamous birds—sexual selection cannot be operative. The effect of the ceremonies in these and many other species is not the selection of one rather than another out of several possible mates, but simply a facilitation of the union of the gametes.

Now copulatory organs have exactly this same function. When internal fertilisation is employed, copulatory organs are in the majority of cases developed. They are an adaptation to a particular method of fertilisation. In precisely similar fashion I would say that when organisms possess a certain grade of mental (nervous) development one of two further adaptations is required to facilitate the union of the gametes. Either, as in mammals, a hormone is periodically produced which causes the female at certain times to be ready to take any male, while at others she refuses all males; in this case displays and ceremonies will be useless, and fighting between males will be the rule. Or else the stimulus to make the female ready to take the male must come from without; it must, therefore, affect the nervous system through the sense-organs, and will generally take the form of a display by the male.

If the female were at all times ready to take the male, excessive coition would occur, which would be deleterious; thus it is desirable that some stimulus, whether endocrine or sensory, internal or external, should be necessary in order that coition may take place.

I have so far purposely simplified the problem by dealing only with those species in which it is the female who needs stimulation, the male who is always or usually ready for coition and performs the special ceremony. The reasoning, however, will equally apply to cases of "reversed sexual selection," such as the Phalarope, where the female is more brightly coloured and the male requires stimulation, or to the numerous cases of "mutual courtship," such as is found in grebes, divers, egrets, herons, the kagu, the fulmar, etc., in which both sexes are brightly coloured,

both play similar *rôles* in the ceremonies, and apparently both equally need excitation for coition to take place. Here mutual, instead of one-sided, excitation occurs.

It will be evident that wherever mating displays and ceremonies, and the colours and structures associated with them, have this purely stimulative function they cannot be supposed to stand in any relation to sexual selection, but resemble copulatory organs in being solely subservient to efficiency in securing union of the gametes. Copulatory organs will arise only when a certain level of general physical complexity is reached; stimulative displays, colours, and structures only at a certain level of sensory and nervous (mental) complexity.

The problem of their genesis is therefore no more difficult than that of copulatory organs, or, indeed, of any other adaptive structures—which is not to say that it is easy, but that at least it does not demand special evolutionary agencies.

When polygamy obtains, true sexual selection may, of course, occur, and from observations such as those of Selous on the ruff and blackcock (Selous, *Zoologist*, 1906 and 1909–10), does definitely seem to be operative.

To denote characters which are secondarily concerned with bringing about mating or copulation we may use the term "epigamic," first coined by Poulton. It is necessary to have such a term, since "secondary sexual" cannot be applied to epigamic characters occurring in both sexes, and can be applied to non-epigamic characters such as mammæ. Characters effective in the act of copulation itself (copulatory organs) come under the head of "accessory sexual characters." Epigamic characters are then either "accessory," when they stimulate to coition, or "sexually selected," when they stimulate to the selection of mates. In certain cases they may be both. There is, however, good reason for believing that the great bulk of sexual displays, with their associated colours and structures, are accessory epigamic characters, and that the problem of their evolutionary origin is therefore simplified.

JULIAN S. HUXLEY.

New College, Oxford, December 7.

Terrestrial Magnetic Disturbances and Sun-spots.

REFERRING to Father Cortie's letter on this subject (NATURE, October 27, p. 272), the sequence of magnetic disturbances following at 27-day intervals the storms of May 12–21, 1921, was recorded also at Kodaikanal, but those storms recorded in England as "very great" on September 2 and 28–29 were classed here as "moderate" only. There were also recorded here "great" storms on March 21–22 and April 18–19, which appear to belong to the same sequence, the whole interval from March 22 to September 29 giving a mean period of 27·29 days. Assuming this to be the synodical period of the sun, the equivalent sidereal period is 25·42 days, closely agreeing with Carrington's mean value of the rotation for spots.

Our spectroheliogram records show that the spot disturbance originated on the invisible hemisphere of the sun shortly before May 8, when it first appeared on the east limb as a condensed mass of bright calcium flocculi. As is usually the case, the area of disturbance became extended; in July the flocculi were more or less scattered, and the last visible remnants of these are seen in the photographs of August 1–8.

The magnetic disturbances seem therefore to have both preceded and followed the spot disturbance as recorded in calcium light, the flocculi lasting through three synodic rotations and the magnetic effects through seven.

Except during May, there were no striking manifestations of prominence activity recorded here near this group of spots. On May 9 we photographed on the east limb a group of circular interlacing arches such as are occasionally seen over newly formed spots, and during the passage of the group across the visible hemisphere there were very brilliant metallic reversals and other manifestations of eruptive activity, besides innumerable absorption markings in Hα light intertwined throughout the group. All this activity appears to have subsided during the following month.

Another more striking instance of the persistence of magnetic effects long after every trace of solar disturbance has disappeared occurred in the year 1920. The "very great" storm of March 22, 1920, was associated with a very large spot group passing the central meridian on that date. This group and its associated flocculi were observed during five synodic rotations from January 1 to April 18, and each meridian passage was accompanied by a magnetic storm of "great," "very great," or "moderate" intensity. The spot disturbance and its surrounding flocculi completely subsided during May, yet the magnetic disturbances continued to recur at 27-day intervals for seven more periods; the last disturbance to be identified in this sequence was recorded on November 21 as a "moderate" storm. The interval January 1 to November 21, 1920, is 325 days, or twelve periods of 27·08 days. Allowing for the earth's orbital movement during this interval the equivalent solar period is 25·22 days, or Carrington's rotation period for spots in latitude 10°. The slight difference of period compared with that obtained from the 1921 series does not make the evidence for these sequences less convincing; in his discussion of a very large number of such sequences Maunder has shown that the sidereal period derived from them may vary from 25 days to 26·5 days (Monthly Notices, R.A.S., vol. 65, p. 553).

J. EVERSHED.

Kodaikanal, November 28.

Microscope Illumination and Fatigue.

THE further letter from Mr. H. J. Denham in NATURE of December 15, p. 496, does not in any way alter my opinion that the method of varying the intensity of illumination in the microscope described by him is not the best or the most convenient at present available. The use of a monochromatic light-filter does not affect the question, as such an accessory is used or not as may appear desirable in any given circumstances. At this institute several sources of light are installed, the one that is regarded as the most useful in high-power work being the mercury vapour lamp. It is obvious, therefore, that if light-absorbing screens of known opacity are available, nothing further is needed whether the light is monochromatic or otherwise. As I have already stated, such screens as we use here alter the intensity, and not the character, of any visible light which they transmit. If Mr. Denham regards the change of quality of his light as an advantage, I do not think that many microscopists will agree with him or adopt his methods while more efficient ones are at hand.

As to my experience of the value of variable illumination, it is, in my opinion, an essential feature of any good microscopic outfit. In use it is second only in importance to the proper adjustment of the light and sub-stage condenser. Apart from its advantage to the observer in reducing fatigue, it is often possible to use a larger cone of illumination by reducing the

light intensity. Many workers resort to the sub-stage iris diaphragm for this purpose, with the result that definition and resolution suffer. Where colourless or lightly stained preparations are under examination the advantage of light regulation is considerable, while for dark-ground illumination it is absolutely essential for accurate observation. It is possible that there would be a limited demand for objectives corrected for some small region of the visible spectrum, but whether the advantages to be derived are sufficient to induce any manufacturer in this country to take the matter up I do not know. J. E. BARNARD.

National Institute for Medical Research,
Hampstead, London, N.W.3, December 20.

Prismatic Structure in Optical Glass.

THE specimens of columnar structure illustrated in the accompanying reproductions of photographs (Figs. 1 and 2) were obtained during the manufacture of optical crown glass.

The dimensions of the pot were 24-in. diameter and 24-in. height. After the final stirring, during which the temperature fell to about 1000° C., the

FIG. 1.

pot of glass was withdrawn from the furnace and quenched overall externally with cold water. The pot was then regularly cooled during about eighty hours. Fracturing occurred radially from the centre to the sides and base of the pot. Without further consideration it might be assumed that the columnar fracture commenced at the pot surface, which had been severely chilled, and spread radially

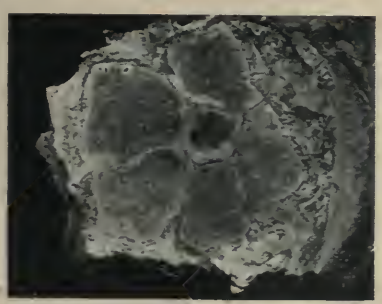

FIG. 2.

towards a central nodule the diameter of which was about 6 in., but such a conclusion is scarcely justified.

It is the central nodule that is of most interest, as it gives a clue to the history of the specimen. The prisms of glass (Fig. 1), which are about 6 in. long, ended abruptly at the nodule surface, which was uniform. To break the nodule was difficult; it behaved like toughened glass. There can be little doubt that its surface-layers were held in compression by the tension of the interior, and, therefore, any surface cracks were held closed, thus preventing fracture. As the prismatic structure ended abruptly at the surface, there being no sign of its continuation within the nodule, it is evident that the surface of the nodule constituting the terminal joints of the prisms was not of later date than the surfaces of the prisms.

At the moment of separation of the nodule its material would tend to move towards its centre. Its surface would move to a place of smaller area, and, being thereby compressed, the formation of normal fractures would be prevented. But the material external to the nodule would withdraw towards the outside. The surface adjacent to the nodule would move to a position of greater area and would crack polygonally. These cracks would instantly spread outwards. That the action started from the centre and not the outside is indicated by the close adhesion of the prisms at their base, as compared with their inner ends. Indeed, it is difficult to trace any passage of the cracks as far as the pot surface.

This sequence of events may throw some light upon the time-relationship of joints and prism surfaces in natural columnar basalt dykes.

To explain the specimen which is reproduced in Fig. 2, about one-sixth full size, is not so easy. In this case the diameter and height of the fireclay pot were each 12 in. It contained a small experimental melt of optical crown glass. At a temperature of about 1300° C. the whole pot of glass was plunged into cold water for about five minutes. It was then cooled regularly during twelve hours. In the glass itself there was no sign of prismatic structure, which was confined to the fireclay base of the pot as illustrated. Most probably the whole action took place during the drastic cooling of the fireclay, the bottom thickness of which was only about 1 in.

The glass itself within a short distance of the surface must have been still quite plastic after five minutes' quenching. Any trace of structure that might exist in the intermediate chilled layer would be lost in the inevitable shattering of this layer that usually occurs. JAMES WEIR FRENCH.

Anniesland, Glasgow.

The Calendar of Scientific Pioneers.

WITH this issue of NATURE the series of short biographical notes on the leading men of science of the past, which it has been my privilege to contribute week by week, comes to an end. It has, however, been considered that it may be of interest to supplement these notes by another series referring to the great pioneers of industry, and the Editor has again entrusted the preparation of this new Calendar to me.

In bringing the Calendar of Scientific Pioneers to a close, I should like to express my thanks to Prof. J. Arthur Thomson, Prof. G. B. Matthews, and others who kindly scrutinised the list of names to be included, and to various correspondents who have supplied me with information. My thanks are especially due to Mr. E. T. Warner, of the Royal Naval College, Dartmouth, who has carefully checked all the notes and has assisted me in other ways.

Great care has been taken to give the correct dates, and where authorities differ, as they often do, inquiries have been made in order to try to trace the source of error. In the case of Joseph Black, for instance, who died on December 6, 1799, but whose death is often stated to have taken place on Novem-

ber 10 or November 26, the error appears to have been due to his contemporaries, John Robison, Adam Ferguson, and Thomas Thomson. So far as I am aware at present, the only corrections necessary in the Calendar refer to Hooke, who died March 3, 1703, according to our present reckoning, and not in 1702, and to Spallanzani, February 12, 1799, who held a chair at Pavia, and not Padua.

Devonport. EDGAR C. SMITH.

The Electric Telegraph.

IN the issue of NATURE of November 17, p. 381, it is stated that "in 1861 telegraphy, the only practical application of electricity, was in private hands. The earliest telegraph was erected on the London and North-Western Railway between Euston and Chalk Farm so far back as 1837 by Cooke and Wheatstone. . . ."

It is strange that no mention is made of the completely equipped reciprocal working electrical telegraph eight miles long (both above and below ground) erected by Francis Ronalds in his garden at Hammersmith in 1816, and fully described by him in a most interesting book published in 1823 ("Description of an Electrical Telegraph and of some other Electrical Apparatus," R. Hunter, 72 St. Paul's Churchyard).

I thought the story of his treatment by the Admiralty in 1816, when he asked for inspection of his telegraph with a view to its substitution in place of the semaphores then (and for years afterwards) in use between London and Portsmouth, was well known. He was informed that "telegraphs of any kind are now wholly unnecessary, and none but that in use will be adopted."

Although Ronalds operated his telegraph by a small frictional hand machine at each end, there can be no doubt—I know he had none—that even with that light charge the eight miles could have been greatly extended, and by larger charges, and, if necessary, repeating stations, it could easily have done what he claimed for it, and he is well known to have been a most cautious, prudent, and accomplished electrician. Had the Admiralty listened to him a solid base would have been laid for the adoption of all the later improvements which have been made, and electric telegraphy would have been in use many years sooner.

The whole of Ronalds's long life showed that his ambition was entirely scientific and not commercial; he took out no patent for his telegraph, but turned disappointed, from telegraphy and devoted himself again to other scientific pursuits, in which he attained much success, as is well known to scientific men not in England alone. He was elected a fellow of the Royal Society in 1844, and was knighted in 1870, three years before his death, for his "early and remarkable labours in telegraphic investigations."

Both Cooke and Wheatstone knew of his telegraph, and referred to it in their quarrels.

Ronalds did not claim to be the inventor of the electric telegraph, the possibility of which had been a matter of discussion for some time by men of science, but rightly claimed to have been the first man to erect and equip an effective working telegraph eight miles long, and capable of indefinite extension. His book shows that he clearly foresaw the future of electric telegraphy.

J. C. CARTER,
A Trustee of the Ronalds Library.
65 Sussex Gardens, W.2.

THE reference in our Note was to the first *commercial* telegraph. The history of the invention of the telegraph is well known, but importance must be attached to inventions on the lines on which it developed. A model of the pith-ball telegraph of Francis Ronalds is in the collection of telegraphic apparatus in the Science Museum, South Kensington. It is interesting to remember that perhaps the first practical suggestion of an electrostatic telegraph was given in an anonymous letter to the *Scots Magazine* (vol. 16, p. 73, 1753). It was suggested that as many insulated wires should be used as there are letters in the alphabet. There is good reason for thinking that the letter was written by Charles Morrison, a surgeon and a native of Greenock.

THE WRITER OF THE NOTE.

The Hydrogen-ion Concentration of the Soil in Relation to Animal Distribution.

THE striking relationship between the hydrogen-ion concentration of the soil and plant distribution is apparently not without its parallel in animal distribution. A number of facts concerning the relationship of certain forms of animal life to plant-hosts have been brought together by Fr. Dahl ("Grundlagen einer ökologischen Tiergeographie," Jena, 1921). He states that a great many animals are exclusively, or almost exclusively, found on certain plants. The association of the silkworm with the mulberry tree is known to all, and it is only with difficulty that it can be brought to feed on any other leaf than that of the mulberry.

Since this is so, it follows that animals which inhabit or feed on plants found in regions of alkaline soil must be absent, or almost absent, from those in which the soil is acid. Conversely, the parasites of acid-soil flora must be absent from those large tracts where chalk, limestone, or calcareous silt are found.

The distribution of worms with regard to the reaction of the soil offers an interesting field of study. The same holds true for the distribution of fresh-water plankton. Soft water, such as that of Dartmoor, is slightly acid, pH6·4–6·8, owing to excess of carbon dioxide in solution, whereas running water, in regions containing appreciable amounts of calcium carbonate in the soil, is close to the bicarbonate equilibrium point, pH8·3–8·4. These differences appear to have considerable biological significance, as is easily appreciated when one recalls that it has been shown by Prof. B. Moore that the relationship of an amphoteric colloid to its ions depends upon the ratio of the hydrogen and hydroxyl ions, namely, upon the square of the hydrogen-ion concentration.

It may be added that in regard to the influence of the hydrogen-ion concentration upon plant distribution the additional factors emphasised by Mr. N. M. Comber (NATURE, September 20, p. 116), and Mr. E. A. Fisher (November 3, p. 306), in criticism of the present writer's letter on the subject (September 15, p. 80), are of undoubted importance and have been discussed elsewhere. They were omitted from the short letter in NATURE to make the main idea clearer.

W. R. G. ATKINS.
Marine Biological Laboratory, Plymouth,
December 13.

Relativity and Materialism.

DR. N. R. CAMPBELL in his interesting letter in NATURE of November 24 says that the belief that matter is real is quite unaffected by the principle of relativity, if the word "real" is used in the commonsense way, which is the only way in which the notion of reality is ever used in physics. He also says that the principle of relativity may lead us to assert that some things are real which we should otherwise have asserted to be not real. With these assertions I am in cordial agreement.

I dissent completely, however, from his statements that "the criterion of this common-sense reality is universality of experience," and that "the mongoose was unreal because if the box were opened nobody would experience it." There is no such thing as a universal experience, and nobody would experience the mongoose, whether it was real or not. The only things we experience are sensations and certain processes, such as judgments and emotions, which we call mental. Each sensation or each judgment is absolutely private to one individual. Other people's sensations and judgments can be described to him, but he can appreciate them only through other sensations of hearing and seeing, and these are just as private as the first kind. Any satisfactory account of scientific method must therefore rest at bottom on the private sensation and the individual judgment. Other people provide me with additional data, but I make my decisions about them myself.

The common-sense criterion of reality, I contend, is that a large number of the sensations of the observer can be described in terms of a small number of assumed properties of the object by means of logically or mathematically simple laws. It is an experimental fact that this is possible with respect to many objects. In fact, the scientific notion of reality is securely based on experience, and cannot be altered by any argument or theory. Some realist philosophers would probably say that this criterion gives grounds for believing that something is "real" in a different sense from this; but, like Dr. Campbell, I find myself quite unable to understand what philosophers do mean by "real." To me the above criterion is the definition of reality. The fly on this sheet of paper (at the moment) is unreal because there are no sensations that can be concisely described in terms of it.

I question Mr. Hugh Elliot's assertion that "materialism happens to be true." I do not deny it, but I deny absolutely that Mr. Elliot knows it. Mental operations may be a function of material ones, but to find this out it would be necessary to show how all mental phenomena can be inferred from physical and chemical hypotheses, and this will never be known until psychology is a complete science. Materialism will be established, if at all, only at the very end of science. At present it is pure metaphysics.

HAROLD JEFFREYS.

St. John's College, Cambridge.

IN his article in NATURE of October 20, p. 247, Prof. Wildon Carr has maintained that the relativity theory has made the reality of matter untenable. Later writers have denied this. May I state the relation of their views?

Einstein refers the universe to a system of axes fixed to an observer. The observer is a mind, and hence Prof. Carr regards the material axes as also of the nature of mind. The opponents of this view, accepting the axes as material, regard mind as derived from matter. The four axes of Einstein have no physical counterpart in matter. But the relativists have not envisaged any reality for the axes other than a material reality. Therein, it seems to me, lies the weakness of the relativist position.

The four-dimensional universe of Einstein is a hybrid made of mind (the observer) and matter (the axes). The material axes are the measuring rods of the observing mind. So long as we retain this hybrid character it is equally easy for opposing sides to claim mind or matter as the fundamental reality. The metaphysical definition of reality is that the ultimate is the real—that is, that the entity from which all other entities can be built up is the real. Science is not only concerned with the real of common sense, as Dr. Norman Campbell seems to think, but is also concerned with the real of metaphysics. The former may be regarded as a horizontal section of reality and the latter as a vertical section—the breadth and depth of reality.

What the relativists have to show to substantiate the claim that mind is the ultimate reality is how to build matter from mind. The axes of reference, and not merely the origin, have to be of the mind-stuff. Then the universe would be perceived as a universe of mind-stuff. This is possible. A four-dimensional geometry of a universe of mind-stuff has yielded me a law of gravitation which is the analogue of Newton's first law of motion and automatically solves the problem of n bodies. The elaborate froth of the Einsteinian tensor analysis for obtaining the law of gravitation is due to the putting of the new wine of mind into the old bottles of material axes. In the four-dimensional universe of mind-stuff matter, space, and time find their place as growths from mind.

S. V. RAMAMURTY.

Trinity College, Cambridge, December 9.

CANON MCCLURE's misconception is so fundamental that I ask leave to correct it. If he had done me the honour to read other of my writings, he would scarcely have suspected me of a desire to banish imagination from science. It is just because I maintain that the imaginative element gives to science its highest value that I think it important to distinguish carefully between what is fact and what is imagination. I do not "rule out, as scientifically invalid, Prof. Eddington's being travelling with the velocity of light"; but I say that the perceptions of that being are not facts, ascertainable by experiment; and I protest against any exposition of relativity, or of any other scientific doctrine, which confuses laws, based mainly on facts, with theories, based mainly upon imagination.

NORMAN R. CAMPBELL.

The Resonance Theory of Hearing.

Is it possible for the ear to distinguish two notes of the same pitch and of different quality sounding concurrently?

Evidently it is possible. Of a number of examples the following may be the simplest for experiment. Hum any note with the teeth touching, but not clenched. The performer may then hear the smooth hummed note and at the same time another rough note of the same pitch produced by the tapping of the lower teeth against the upper teeth. (Stop the ears.) Now imagine a tracing of the combined wave-form of any two notes of the same frequency to be submitted to the Fourier analysis. The result of the analysis must always be of the same nature; there is no alternative; "la solution est unique":—the complex sound giving the periodic curve will be shown to be made up of a series of pure tones of the harmonic scale with frequencies n, $2n$, $3n$, etc. If the ear acts as a kind of "practical Fourier's theorem" it can perceive only one fundamental tone. But we invariably judge of the pitch of a note by its fundamental tone. If, then, we hear at the same time two notes of pitch n, the ear must be able to perceive, also at the same time, two fundamental tones of frequency n—that is to say, it must be able to perform an analysis which is not in accordance with Fourier's theorem.

I mentioned this radical objection to the resonance theory of hearing in 1916 ("Questions of Phonetic Theory," p. 100), but nobody appears to have noticed it.

W. PERRETT.

University College, Gower Street, W.C.1, December 13.

Next Year's Total Solar Eclipse (September 21, 1922).

By MAJOR WILLIAM J. S. LOCKYER.

IN September of the coming year there will be a very favourable total eclipse of the sun, and several expeditions are preparing to proceed to stations on the narrow track of the moon's shadow. This eclipse is a member of an important family, from the point of view of solar physics, because one of its predecessors was the memorable eclipse of August 18, 1868. On this occasion the astronomical equipment was enriched for the first time by the use of the spectroscope for such work, and the important discovery of the gaseous nature of the solar prominences during that eclipse was the forerunner of very rapid advances in solar research. The track of the shadow was slightly to the north of the coming one, and passed over North-East Africa, India, Java, and North Australia. It was in India that the memorable observations were made.

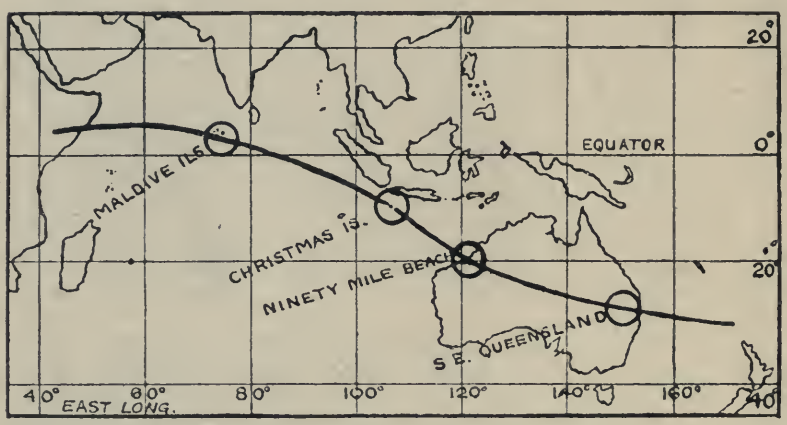

FIG. 1.—Shadow track during total solar eclipse of September 21, 1922.

The two immediate predecessors of the coming eclipse took place on September 9, 1904, and August 29, 1886. The first of these was confined to the Pacific Ocean, where no observations were made. The second commenced in the north of South America; the track then crossed the Atlantic Ocean, finally crossing South Africa, and terminating in Madagascar. Unfavourable weather prevented many observations being made.

The line of totality of next year's eclipse commences on the north-east coast of Africa, leaving it at Somaliland. It then cuts through the Maldive Islands, which lie to the south-west of India, skirts the East Indies, but passes over Christmas Island, which is situated about 200 miles to the south of the sound between Sumatra and Java. The line next strikes the Australian continent at a region called Ninety Mile Beach, crosses the continent nearly centrally, and leaves it at the coast of South-East Queensland. It ends in the ocean just to the north of the North Island of New Zealand.

The line of totality is shown on the accompanying figure, and it will be seen that it affords four regions (marked with circles) well distributed along it from which observations could be made.

On the north-east coast of Africa the eclipse occurs when the sun is near the horizon, so this region is not favourable for observational work. Farther east, the Maldive Islands present a good station. There the sun is well up, having an altitude at eclipse time of about 34°, and the duration of the total phase is 4m. 10s. The weather prospects seem to be good. It is probable that special arrangements would have to be made to reach the islands, as there is no scheduled line of steamers. It is not yet known which of the islands will be occupied, but Admiral Sir A. Mostyn Field points out (Monthly Notices, R.A.S., vol. 81, No. 5) that care must be taken as regards selection owing to possible landing difficulties. Thus in the case of the island of Dambidu (lat. 2° 5′ N., long. 73° 34′ E.) charts seem to indicate a broad shelf of reef more than a mile in width, extending from the island on the lagoon side: the presence of coral heads separated by deep pools may therefore be expected. It is very probable that Mr. John Evershed, the director of the Kodaikanal and Madras Observatories, will proceed to this station, and his work will include spectroscopic observations on a large scale.

At Christmas Island, in the Indian Ocean, the sun will be well up towards the zenith—in fact, it will be nearly noon there—and the duration of totality will be 3m. 40s. This island is not exactly in the centre of the zone of totality, but about fifty miles from this centre. The prospect of clear weather at this tropical island is only moderate, but from experience at such islands little dependence can be laid on average conditions of weather.

The British Joint Permanent Committee has decided to occupy this island. Two members of the staff of Greenwich Observatory, Mr. H. Spencer Jones and Mr. P. J. Melotte, have been chosen to proceed there to obtain the necessary photographs. The special object of this expedition is to make a new determination of the deviation of the light of stars in the gravitational field of the sun. The instrument to be employed is the 13-in. astrographic telescope on a special equatorial mounting. It may be remarked here that usually on such expeditions telescopes mounted equatorially are not used. The tubes containing the object glass and camera attachments are generally mounted horizontally, and the

light is reflected into them by means of a clock-work-driven plane mirror called a "siderostat" or "cœlostat." Unfortunately such mirrors, owing to changes of temperature, do not remain "plane," but become slightly curved, thus rendering it very difficult to keep the telescope in perfect focus. Pointing the telescope directly at the sun and keeping it clock-driven on an equatorially mounted stand eliminates all such difficulties.

Numerous photographs of the stellar field in which the sun will lie at the time of the eclipse have already been secured to compare with those that will be taken during totality. The expedition will reside six months in the island previous to the eclipse, and will, in addition to other work, make a comparison between the photographic scales of stellar magnitude in the north and south hemispheres. Even if the eclipse be not observed owing to possible bad weather, some very useful work will have been accomplished. The Christmas Island Phosphate Company will assist the observers by levelling the site, erecting the concrete base for the equatorial, and putting up the necessary huts, thus rendering valuable assistance in the cause of astronomy. An expedition from Batavia, in Java, will also take up its station on this island. Mr. J. G. Voûte will be the leader, and the party may possibly camp near the Greenwich observers to take advantage of the available local assistance.

The region on the north-west coast of Australia, where the shadow next strikes land, known as Ninety Mile Beach, is perhaps the most favourable station from the point of view of weather. This area of the continent is excessively dry, and the percentage of cloudiness small. The sun's altitude will be 58° and the duration of totality will be comparatively long, namely, 5m. 18s., at a post station named Wollal. Wollal lies about 200 miles to the south-westward along the coast from Broome. Commercial steamers run from Perth to Broome, and at the latter place local small schooners or launches can be chartered to beach near Wollal. Prof. A. D. Ross and Mr. R. D. Thomson, of the Perth University, have published (Monthly Notices, R.A.S., vol. 31, No. 3) a large amount of useful local information about Wollal. Good water, fuel, and unskilled labour are available.

It is definitely known that a party of astronomers from the Lick Observatory in California, under the direction of Prof. W. W. Campbell, the director of the observatory, will take up their station there, and it is hoped that an Australian party will occupy a position on the west coast in addition to one or more on the east. The work of the American party will probably include in its programme the photography of the corona, and spectroscopic investigation of the chromosphere. In South-Eastern Queensland the shadow passes consecutively over Cunnamalla, Goondewindi, Stanthorpe, and Casino. The first of these lies well inland to the south of Queensland, about 475 miles from the coast, and totality lasts 3m. 45s. This station is more difficult of access than the other three, but lies on the Western Railway of Queensland.

Goondewindi and Stanthorpe, 180 and 100 miles respectively from the coast, lie just to the north-west of the New England range, and the railway is also available. Casino, to the north-east of the range, and only thirty miles from the coast, is on the railway, and therefore quite easy to occupy. The nearer the coast is approached the more chance there is of unfavourable weather conditions, so the most distant inland station, Cunnamalla, is from this point of view the pick of these stations.

Mr. W. E. Cooke, the Government astronomer of New South Wales, has published a pamphlet, which is full of detail, of local notes on the selection of sites in Australia, and the large-scale map of the Queensland region which accompanies it should prove very useful. Mr. H. A. Hunt, the Commonwealth meteorologist, has also issued a weather card showing the duration of the wet seasons on the line of totality.

The Australians are very keen that British astronomers should take up their stations on their continent, for at a public meeting held recently at Adelaide under the presidency of the Governor, a resolution was adopted inviting British astronomers to view the eclipse there. It was urged that Australia was superior to Christmas Island because of the clear sky, particularly in the high northern district.

While reference has been made only to official expeditions which will be taking advantage of this favourable eclipse, there will no doubt be other parties which will proceed to one or other of the above-mentioned localities. The sun itself will most probably be in a state of quiescence, judging from the recent low activity of the solar atmosphere, and from the fact that the last maximum of spot disturbances occurred in the year 1917. Thus the form of the corona will most probably be of the "windvane" type, in which the coronal streamers are restricted to the lower solar latitudes, while the regions of both poles will be conspicuous by the presence of the well-known polar rifts.

It is well known that some eclipses are termed "dark" or "bright," according to the visibility of the distant landscape, near objects, or the face of a watch held in the hand. Owing to the low state of solar activity and to the long duration of totality, next year's eclipse would be expected to be of a "dark" nature. If this be so, then the coming event will be more favourable for photographing those stars that are apparently near the sun than was the case on the last occasion, when such successful photographs were secured for making one of the tests connected with the theory of Einstein.

Spontaneous Combustion of Coal in Mines.

THE causes underlying the occurrence of fires in mines which have as their source the self-heating of coal have for many years occupied a leading place in the minds of those responsible for the winning and working of coal seams. Whilst cases of spontaneous combustion have occurred in most of the coalfields of this country, it is undoubtedly the fact that certain districts, and particular seams in those districts, are much more liable to its occurrence than others.

Under the Coal Mines Act, 1911, cases of fire below ground are included amongst "dangerous occurrences" and are notifiable to the Inspector of Mines. A consideration of the number of fires so notified in the various inspection districts during the past few years enables the districts to be classified in the following descending order of liability, viz:—

(1) Midland and Southern Division (including the coalfields of South Derbyshire, Leicestershire, North and South Staffordshire, Worcestershire, Warwickshire, Bristol, Somerset, and Forest of Dean).

(2) York and North Midland Division (including the coalfields of Yorkshire, Derbyshire, and Nottinghamshire).

(3) Scotland Division (comprising the whole of the Scottish coalfields).

(4) Lancashire, North Wales, and Ireland Division (including the coalfields of Lancashire, Cheshire, and North Wales).

(5) South Wales Division (including the South Wales coalfield).

(6) Northern Division (including the coalfields of Northumberland, Durham, and Cumberland).

It will, of course, be appreciated that the greatest danger from spontaneous combustion occurs in mines in which large quantities of fire-damp are generated, and it is fortunate that the mines of South Staffordshire and East Worcestershire, where the greatest liability to fire has hitherto existed, are comparatively free from gas of an explosive nature.

In the First Report of the Departmental Committee on Spontaneous Combustion of Coal particulars are given of the fatal accidents attributable to this cause during the period 1893–1912, from which it appears that 177 persons lost their lives. This figure represents only about 0·9 per cent. of the total death-rate from all causes underground during the same period, and speaks well for the vigilance and care that is exercised in dealing with the trouble from a practical mining point of view, to which reference is made in the last paragraph of this article.

Apart from the danger to life, the prevalence of self-heating of coal in mines gives rise to increased cost in working, and frequently entails the loss of large areas of the seam, it being no uncommon thing for a district of a mine to be temporarily dammed off, while in some cases the entire workings of a mine have had to be temporarily abandoned, the shafts sealed, and the fire allowed to burn itself out.

In examining the causes which give rise to spontaneous combustion it will be of interest to note what conclusions can be arrived at from a consideration of the conditions existing in those districts where fires have been most prevalent. Reference has already been made to the frequency of fires in the South Staffordshire coalfield, and an analysis of these reveals the fact that by far the greatest number have occurred in the famous Thick Coal Seam, which ranges in thickness from 24 ft. to 42 ft. In Warwickshire the greatest tendency to spontaneous combustion is found in the Warwickshire Thick Coal, which in the southern part of the county has an average thickness of 23 ft. Towards the north the Thick Coal splits up into several seams, and it is only where these occur in close proximity that the liability to fire is still present. In Yorkshire the Barnsley Seam, 10 ft. in thickness, and in Fifeshire the Dysart Main Seam, varying from 8 ft. to 26 ft. in thickness, are the seams in which fires chiefly occur. In every other district where spontaneous combustion has occurred (*a*) the seam is either of abnormal thickness, or (*b*) seams of moderate thickness lie in close proximity, or (*c*) the working of the whole of a seam of coal is interfered with by the presence of faults or other dislocations of the strata.

In the working of thin seams it is possible to extract the whole of the coal in one operation, and the débris made in the working of the coal permits of the "goaf"—or space from which the coal has been extracted—being stowed tight, and in these cases spontaneous combustion is practically unknown. In the working of thick seams or seams lying close together it is impossible to extract the coal so cleanly or to pack the "goaf" so tightly, with the result that the "goaf" does not so quickly become consolidated, and a varying proportion of crushed and broken coal is left in proximity to cavities or fissures containing still or moving air. It is in such cases that underground fires occur.

Whilst practical mining men have been learning by experience the conditions favourable to the inception of fires and the methods of working by which these are best combated, the scientific investigator has also been, and still is, at work on the same problem. The oxidation of the iron pyrites which frequently occurs in the coal in one form or other was for long commonly accepted as the primary and principal cause of spontaneous combustion therein, but it is now recognised that this is merely a contributory factor in certain cases, and that the real cause is oxidation of the coal substance itself.

It has been fully established that coal takes up oxygen in two ways—viz. by chemical combination or "absorption" with evolution of heat, and by solution or "adsorption" without any considerable evolution of heat, and that with certain

coals, as the temperature rises, the rate of absorption of oxygen increases. It is this chemical combination of the coal substance with the oxygen of the mine air which causes underground fires, and it follows that coal in a powdered or finely divided state, presenting a large air surface, is the most readily subject to heating. The scientific investigation of the phenomena surrounding the self-heating of coal has made rapid strides during the past ten years, and much credit is due to those responsible for the patient research work carried out at the various coal owners' research laboratories, chief amongst which is that of the Doncaster coal owners, established at Bentley Colliery in 1913, and lately removed to Birmingham University. A summary of the work accomplished was recently given in a paper read by the director, Dr. J. S. Haldane (Transactions of the Institution of Mining Engineers, vol. 53, pp. 194, etc.).

By accurate measurement of the relative absorption of oxygen by different coal seams it has been found that there is a very wide divergence in capacity. The Welsh anthracites and steam coals, for example, are found to have a small, definite capacity for oxygen which is not altered by increase of temperature, and these cannot, therefore, fire spontaneously. The same properties are found in most of the Durham coal seams, and it is well known that these two coalfields are practically immune from spontaneous combustion of coal.

A very close study has also been made of the changes in the composition of mine air brought about by the self-heating of coal, with the result that by a system of analysis it is now possible to obtain an early indication of the presence of the self-heating of any coal seam. It will be apparent, therefore, from a practical point of view, that the fullest information should be available as to the chemical and physical phases of self-heating, in view of the changes that are constantly taking place in the conditions of mining coal. The working of the deeper seams, with consequent increase of pressure due to superincumbent strata, as well as increased temperature, is bringing factors into play which will undoubtedly increase the tendency to spontaneous combustion. This is very noticeable in the case of the extension and development eastwards of the Midland coalfield in Yorkshire, where the Barnsley Bed Coal is being worked at increasing depths. The thickness of the seam varies from 8 ft. to 11 ft., and it is not practicable to extract the whole of the coal, owing to the danger arising from falls of roof. The depth of the seam varies from 600 to 900 yards, and the temperature of the workings is considerable. The result of these conditions is to render the seam liable to spontaneous combustion, contrary to what prevails in the extensive workings to the west, where the seam is shallower.

Various remedies have been suggested from time to time for dealing with the occurrence of spontaneous combustion. One well-known man of science has suggested that the oxygen content of the mine air should be reduced by mixing inert gases with the ventilating current, but such a course cannot be regarded as practicable. The application of hydraulic stowing has also been suggested, the principle being to replace the coal, contemporary with its extraction, by sand packing flushed into the workings from the surface, thus effectually filling up the wastes and excluding all air therefrom. Whilst this method of working has been utilised with success to a limited degree in Fifeshire, it is not economically possible of general adoption. One of the conclusions arrived at by the recent Departmental Committee on Spontaneous Combustion was that, generally speaking, the methods of working in vogue in the various districts where liability to spontaneous combustion exists are those best calculated to get the coal with the least danger of fire, and to give the greatest facilities for dealing with outbreaks. This expression of opinion is not only complimentary to the mining profession, but also satisfactory to members of the public interested in the safety of mines.

Countries as Personalities.[1]

By PROF. H. J. FLEURE.

TO emphasise the State as the most important human grouping on the large scale leads us so far astray that even some serious students of social psychology try, with obvious ill-success, to discuss the psychology of whole nations like France, England, and Germany. The very inadequate justification is that a political group like a nation-State usually has one official language and tries to organise one educational system and thus endeavours to develop a common measure of social heritage and early experience to unify its population. As a matter of fact, unity of language within a State is not so common as one imagines. Spain has Basque, Catalan, and Galician; France has Basque, Provençal, Breton, Flemish, German, besides her dialects related to Languedoc and Langue d'oil. Germany has many dialects and also Wendish and Yiddish; Finland has Swedish and now also a Lapp element, and so on; while Switzerland has built successfully upon toleration of language diversity. This illustrates the diversity of biological units even within the most modern States, while the very noticeable trend in the treaties towards rearrangement of Central Europe on a language basis emphasises the fact that the biological unit has been uneasy

[1] Abridged from a citizens' lecture delivered at Edinburgh on September 12 during the meeting of the British Association.

under the political conditions of the centuries since the rise of the organised nation-State.

The fear of war between sovereign nation-States encourages schemes for reducing diversities within a State in the interests of that unity necessary for military efficiency and governmental discipline. If we were secure from fear of even European war our Irish problem would be transformed and reduced. The enforced administrative unity of France is admittedly a heavy burden imposed by military fears. The ideal of government is to allow scope for the expression of the social heritage of biological units, and it has become evident that the European system must be progressively modified to lessen the influences that inhibit that expression, as well as to promote toleration and understanding between diverse forms of that expression. We must therefore study biological social units to discover those which have special importance, as well as to emphasise the contributions they can make under improved conditions to the common stock of civilisation. It is unrestricted State-sovereignty and the armaments-fever thereby promoted that give rise to these dangerous inhibitions of biological units of mankind whereby civilisation is imperilled.

To ascertain what are effective biological units and what their characteristics and possibilities we need co-operation between anthropologists, historians, geographers, and economists at the very least, and anthropology must be broadly defined to include physiology and psychology too. The development of this co-operation is one of the most important tasks facing the branches of science dealing with man, and it is greatly to be hoped that it may break down artificial barriers such as those between the faculties of arts and of science in universities.

The geographer studies environmental conditions, past and present, and tries to follow the subtleties of the interaction on both sides between them and mankind. Russia, with its hundred millions of men of European stock, is too often crudely contrasted with the sixty millions of Germany and the thirty-nine millions of Frenchmen, and so on without due regard to the diversity of mankind. On the Russian plain for months in the winter the temperatures are too extreme nearly everywhere for the maintenance of mental efficiency among the generality of the people. People thus cut off from effective criticism for a part of the year must rely on routine, and a traditional rule of life will suit them best. These difficulties of life on the Russian plain are well brought out by Tolstoi in "Anna Karenina," but are too little considered in political arguments. Again, the long rainless periods in Russia, apparently the chief factor in limiting the beech tree to Europe west of the Pripet Marshes, imply hindrances to westernising agriculture there. The reactions differ in the various latitudinal zones of the pine forest, the oak forest, the forest and grass regions, the steppe and waste regions, and thus, by adding differentia, we get to biological units within the inchoate mass of Russia, and it is these units that are the geographical personalities rather than Russia as a whole.

Studying orography in place of climate, we find the regions of high relief with deep valleys sharply cut off from one another giving rise to small units that preserve and accentuate differences of ancient origin. We find, too, that among them that process of linking man with the soil which has done so much to make Europe what it is has been delayed, and traces persist of seasonal movements up and down hill, of social organisation on a basis of kinship not yet superseded by that basis of neighbourhood on which modern European administration is built. The Scottish Highlands of the eighteenth century and Albania in the twentieth century may be quoted here.

Again, studying relations of position, we are led to see how remarkably communications affect geographical personality. Islands adjacent to larger land masses show different, frequently conflicting, developments of geographical personality within them, and these are related to differences of outlook towards adjacent shores. Guernsey has 37,000 people on 25 square miles and a uniquely intensive system of cultivation largely in the hands of families long settled in the island. Yet one can distinguish about three regional dialect differences, and there are also regional differences of family names and of physical type all of very old standing. "Lewis and Harris" in the Hebrides shows this remarkably, with dark, long heads in Harris, Nords near the Ness, and people with broad heads and dark colouring in the Barvas district. Anthropologists know that these differences are of very old standing indeed. Ireland is a tragic instance of diversity of outlook within an island, and Ceylon, Java, Madagascar, and many more also illustrate this point. Britain itself is less unified than the Paris Basin, and it may well be the hope of its citizens that its efforts for promoting "unity in diversity" may contribute very much to the solution of the problem of the world's peace—the provision of a world order which shall not create irritation by repression of biological units, thwarting geographical personality.

It is, however, not only environment that contributes to geographical personality; the work of man is so important in its cumulative effect that one can scarcely think of a real development of geographical personality without it. In Neolithic times the lowlands of Europe north of the Alps became forest-covered, where they were not too swampy, and the sparse population, ill-armed to cope with the forest, lived mainly on any patches kept open by looseness or dryness or special exposure of the surface. The forest was the dark abode of wild beasts that made the whole region unfriendly and full of obstacles to intercourse and growth of ideas. In the last phase of the Bronze age the cutting of forests seems to have begun seriously, and this period and the Early Iron age witnessed efforts to spread dominion over the

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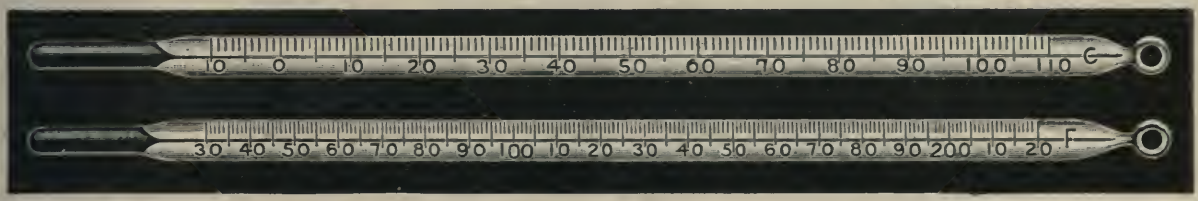

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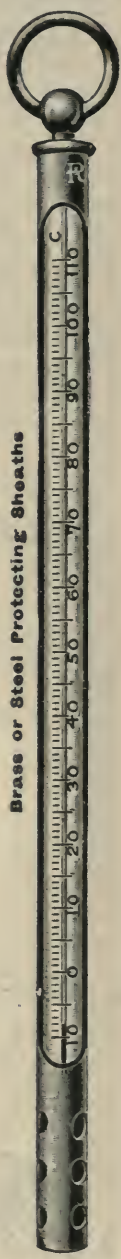

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On the Beating Tones of Overblown Organ Pipes. By V. Lough, B.Sc., A.R.C.Sc. (Plate I.)

The Probability of Spontaneous Crystallization of Super-cooled Liquids. By C. N. Hinshelwood, Fellow of Trinity College, Oxford, and Harold Hartley, Fellow of Balliol College, Oxford.

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On a Type of Oscillation-Hysteresis in a Simple Triode Generator. By E. V. Appleton, M.A., M.Sc., and Balth. van der Pol, Junr., D.Sc.

Polarization Phenomena in X-Ray Bulbs. By S. Ratner, University of Manchester.

Röntgenograms of Strained Crystals. By A. F. Joffe and M. V. Kirpitcheva. (Plate II.)

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regions of the forest. Roads appear to have been made and villages built along the hillsides, and the heroic age tells of adventurers seeking fame and fortune by domination of territory dotted with these villages of deeply engrossed cultivators. The later organisation of power, especially in France, promoted the cutting of the forests, and market towns grew in what now became cornland, until, with the end of the Middle Ages, the growth of communication made the forest in many parts little more than a memory though still dominant in remote corners. The change of personality from the unfriendly forest full of wild beasts to the rich cornland dotted with villages focussing on market towns, is one of the most striking changes the earth has suffered since man spread over it. In the process is wrapped up more of the evolution of the nation-State and of our modern political-linguistic difficulties than we are apt to realise.

Healthy interrelations between geographical personalities are matters of urgent concern. There is special need to think of the remote corners, the Scottish highlands, the Welsh valleys, the Irish West, with conditions of hard effort for small return, and consequently with the export of men and women as a leading function. The value of this function is incalculable, for the great city eats up men and women soul and body, and until we have altered the basis of society our one hope of avoiding collapse is to have a stream of supply from the remote corners where treasures of ancient thought and inspiration survive and impart faculties especially of discernment and judgment. As Stevenson has it, "an honest old countryman has a sense of communion" with the powers of the universe, but he cannot vary from his faith unless he, "in a strict and not a conventional meaning," changes his mind. If the State does not yet provide education and health grants to the remote corners on a basis of area instead of a basis of population, private effort is at least trying to show the way; city churches help mountain churches, and industrial magnates and their descendants are trying to help the people's effort to equip the youth who go out into the world, as well as, in Wales at least, to maintain the *genius loci*. Such helpful interactions will, however, not only stave off the collapse of our precarious civilisation; they may also keep the remote corner from hardening its activities into dead routine or falling into sheer eccentricity.

In the Midland Valley of Scotland, so open to the sea and the Continent, the inrush of new words ousted Celtic speech, though isolation from England allowed a good deal more of the heritage of Celtic place-names to be passed on than was the case in England, and also helped the Scots law to live, whereas, though the Welsh language persisted, Welsh law died largely for want of an administrative centre. The personality of the Central Lowland of Scotland is thus made very different from that of the rural Welsh valleys, and we see that we may consider geographical personality of many grades developed in regions of diverse size and character and owing much to the accumulated result of human work and intercourse through the ages.

The very large unit must include such wide diversities that, failing unusually strong links, the common measure of memory and feeling that furnishes the mainspring of social action may be low. The very small unit and the very isolated unit are apt to lose balance when intellectual, and perhaps physical inbreeding over-emphasises certain heritages. The healthy mean will generally be found in units smaller than those of the great States of Europe, and this reflection is full of bearing on modern thought about social and political organisation of a world which has become one market for endlessly diverse products of spiritual as well as material kinds.

Obituary.

WE regret to see announced in the *Chemical Age* the death on December 19 last, at the age of seventy-three years, of MR. HENRY ROWLATT AUGUSTUS OERTLING. Mr. Oertling was educated at University College, London, and as a young man entered the balance-making business founded by his father. For more than forty years he took an active interest in the management of the firm, and it was under his supervision and to his design that the short-beam Oertling balance was made. Other types of balance were also developed, and for many years balances suitable for educational purposes, as well as those necessary for scientific work requiring the highest accuracy, have been manufactured so successfully by the firm that the name of Messrs. L. Oertling, Ltd., is now well-known in scientific institutions throughout the world.

DR. JOHN HARLEY, who died at Beedings, Pulborough, on December 9 last, aged eighty-eight, was born in Shropshire, where he studied the geology of the region round Ludlow. He specially investigated the microscopical structure of the skeletal fragments in the Ludlow bone-bed, and published an important paper on this subject in the Quarterly Journal of the Geological Society in 1861. During the following years, while physician at King's College Hospital, London, he contributed several notes on drugs to the *Pharmaceutical Journal*. He also wrote a memoir on the parasitism of the mistletoe, published by the Linnean Society in 1863. Dr. Harley bequeathed his geological collection to the Ludlow Museum.

WE notice with regret the announcement of the death on December 25, at the age of ninety, of DR. G. S. BRADY, F.R.S., hon. professor of natural history in the Armstrong College of the University of Durham, Newcastle.

Notes.

A NEW volume of NATURE will begin with next week's issue, so that in future each of the two volumes published annually will bear the date of a single year. This change has been decided upon for convenience of reference, and we believe it will be generally welcomed. Hitherto reference to a particular year of publication could apply to three different volumes, while the volumes which overlap the end of one year and beginning of another bear the dates of two years. Henceforward the volumes will begin respectively in January and July, and a common source of confusion will thus be avoided. The alteration means that the volume completed with this week's issue extends over four months instead of six, but the new arrangement has such decided advantages that no excuse is necessary in introducing it.

THE following have been appointed presidents and recorders (to whom all communications should be sent) of the different sections of the British Association for the meeting to be held at Hull on September 6–13 next under the presidency of Prof. C. S. Sherrington:—*Section A* (*Mathematics and Physics*): President, Prof. G. H. Hardy; Recorder, Prof. A. O. Rankine, Imperial College of Science and Technology, S.W.7. *Section B* (*Chemistry*): President, Principal J. C. Irvine; Recorder, Prof. C. H. Desch, University of Sheffield. *Section C* (*Geology*): President, Prof. P. F. Kendall; Recorder, Dr. A. R. Dwerryhouse, University College, Reading. *Section D* (*Zoology*): President, Dr. E. J. Allen; Recorder, Mr. R. D. Laurie, University College, Aberystwyth. *Section E* (*Geography*): President, Dr. Marion I. Newbigin; Recorder, Dr. R. N. Rudmose Brown, University of Sheffield. *Section F* (*Economics*): President, Prof. F. Y. Edgeworth; Recorder, Prof. H. M. Hallsworth, Armstrong College, Newcastle-upon-Tyne. *Section G* (*Engineering*): President, Prof. T. Hudson Beare; Recorder, Prof. G. W. O. Howe, Elmswood, Malden, Surrey. *Section H* (*Anthropology*): President, Mr. H. J. E. Peake; Recorder, Mr. E. N. Fallaize, Vinchelez, Chase Court Gardens, Enfield, Middlesex. *Section I* (*Physiology*): President, Prof. E. P. Cathcart; Recorder, Dr. C. Lovatt Evans, National Institute for Medical Research, Mount Vernon, N.W.3. *Section J* (*Psychology*): President, Dr. W. H. R. Rivers; Recorder, Dr. C. Burt, 30 Princess Road, Regent's Park, N.W.1. *Section K* (*Botany*): President, Prof. H. H. Dixon; Recorder, Mr. F. T. Brooks, 31 Tenison Avenue, Cambridge. *Section L* (*Education*): President, Sir Richard Gregory; Recorder, Mr. D. Berridge, 1 College Grounds, Malvern. *Section M* (*Agriculture*): President, The Right Hon. Lord Bledisloe; Recorder, Mr. C. G. T. Morison, School of Rural Economy, Oxford.

MR. E. T. NEWTON, formerly palæontologist to the Geological Survey, has been elected president of the Palæontographical Society in succession to the late Dr. Henry Woodward.

MAJOR-GENERAL THE RIGHT HON. J. E. B. SEELY has consented to accept the office of president of the thirty-third Congress of the Royal Sanitary Institute, to be held at Bournemouth on July 24–29 of next year.

IT is announced in *Science* that Mr. John D. Rockefeller has provided funds for the purchase of the birthplace of Pasteur at Dôle, in the Jura. It will be transformed into a museum, in which will probably be housed an extensive medical and surgical library, with the authentic documents of Pasteur.

A FOSSIL Scopeloid fish with the scales which bore luminous organs especially well preserved has been discovered in the well-known Miocene fish-bed near Oran, Algeria. The fish belongs to the genus Myctophum, and as the arrangement of the luminous organs is clearly seen, its affinities can be determined. According to the discoverer, M. Camille Arambourg (Bull. Soc. Géol. France, sér. 4, vol. 20, p. 237), it is not related to the Mediterranean species, but to one having a wide distribution in the Atlantic, Indian, and Pacific Oceans.

THE council of the Institution of Civil Engineers has made the following awards for papers printed without discussion in the Proceedings of the institution for the sessions 1918–19 and 1919–20, publication of which has been delayed by conditions due to the war:—*Session* 1918–19: A Telford medal to Prof. E. G. Coker (London), a Crampton prize to Mr. F. F. P. Bisacre (Glasgow), a Manby premium to Mr. E. H. Lloyd (Cairo), and a Telford premium to Mr. Rollo Appleyard (London). *Session* 1919–20: A Crampton prize to Prof. F. C. Lea (Birmingham), and Telford premiums to Messrs. A. P. Horne (Aberdeen), S. Blencowe (Buenos Aires), and W. J. Walker and R. Koivulehto (Dundee).

AT the annual general meeting of the Society of Engineers, held on December 12, the following premiums for papers read during 1921 were awarded:—President's gold medal to Mr. G. O. Case for his paper on "The Winning of Tidal Lands in British Guiana"; Bessemer premium to Mr. R. W. A. Brewer for his paper "Some Modern Engineering Practice in America"; Nursey premium to Mr. Alfred S. E. Ackermann for his third paper on "The Physical Properties of Clay"; Society's premium to Mr. W. M. Beckett for his paper on "Northwich Sewerage and Sewage Disposal Works"; and Geen premium to Mr. C. F. Moore, of the Crystal Palace Engineering Society, for his paper on "The Locomotives of the London and North-Western Railway."

THE Physical Society and Optical Society's annual exhibition, which is to be held on Wednesday and Thursday, January 4 and 5, at the Imperial College of Science, South Kensington, will be open in the afternoon (from 3 to 6 p.m.) and in the evening (from 7 to 10 p.m.). Mr. A. A. Campbell Swinton

will give a lecture on "The Johnsen-Rahbek Electrostatic Telephone and its Predecessors" at 4 p.m. on January 4 and at 8 p.m. on January 5. Mr. F. Harrison Glew will give a lecture on "Radium: Its Application in Peace and War" at 8 p.m. on January 4. Other discourses are being arranged. We understand that invitations have been given to the Institution of Electrical Engineers, the Institution of Mechanical Engineers, the Chemical Society, the Faraday Society, the Wireless Society of London, and the Röntgen Society. Admission in all cases will be by ticket only, and therefore members of the societies just mentioned desiring to attend the exhibition should apply to the secretary of the society to which they belong. Others interested should apply direct to Mr. F. E. Smith, hon. secretary of the Physical Society, Admiralty Research Laboratory, Teddington, S.W.

A METHOD, which is to be tried at the London Air Station, Croydon, of finding cloud heights at night by means of a searchlight was referred to in the *Times* of December 19. The method is, however, not new. At South Farnborough observations were made in 1916 in connection with a searchlight station about two miles distant from which a vertical beam was projected. The spot of light on the clouds was first observed with a theodolite, but it was often difficult to locate the brightest part in the telescope. A vertical scale was therefore set up against which the light was observed, the eye being placed in a fixed position. If observations are always made from one place the scale may be graduated to read heights directly; it should be black with white graduations. Heights may be determined from lights of distant towns reflected on clouds. The light from London may be seen fifty miles away on very many moonless nights, and may occasionally be photographed, but, as street-lighting is not always very actinic, colour-sensitive plates are required at such distances, and very long exposures, four or five hours with a lens working at f/4·5. The best conditions occur with alto-cumulus clouds at ten to fifteen thousand feet, but a faint glare extending to very considerable altitudes may sometimes be seen on perfectly cloudless nights.

As a preliminary to the proposed standardisation throughout the commerce and industries of France the Government considered the question of the unification of the methods of measurement at the time in use, and issued in 1919 regulations for the introduction of certain new units in the metre–ton–second and centimetre–gram–second systems. The text of these regulations was reproduced in the Bulletin of the Société d'Encouragement pour l'Industrie nationale for November–December, 1919. In the issue of the bulletin for October last the unit of density, that of a body of mass one ton and of volume one metre cube is explained and its relation to older units set forth. The available methods of determining density are described and the errors liable to occur pointed out. As a result of the discussion methods of determination which depend on the balance are recommended instead of those depending on hydrometers. It is further recommended that to avoid all confusion as to the units used the terms "specific mass" be reserved for the density in the metre–ton or centimetre–gram units, and be used in all commercial and industrial statements and tables. The Baumé degree is to be discarded as obscure and indefinite, and therefore prejudicial to French commerce.

So much attention has been directed of late years to the scientific work of Leonardo da Vinci that any discoveries concerning him are bound to interest those occupied with the study of the history of science. Prof. De Toni has been engaged on a biographical sketch of the physicist Giovanni Battista Venturi (1746–1822), whose "Essai sur les ouvrages physico-mathématiques de Leonardo da Vinci" (Paris, 1797) was among the first works to emphasise the importance of Leonardo's scientific position. In the course of investigating the remains of the correspondence between Venturi and other men of science of his time, Prof. De Toni found in the Reggio-Emilia Library three large volumes of transcripts and digests which Venturi had copied from the Leonardo manuscripts in Paris. It soon became evident that these transcripts had been made between 1796 and 1797 before the manuscripts, generally known as A, B, and E, had had torn from them a number of sheets which were afterwards disposed of and many of which were believed to be entirely lost. The manuscript A consisted of 114 sheets and has now only 63, while E consisted of 96 sheets and has now only 80. Much of this material has now been recovered by Prof. De Toni, and consists largely of descriptions of mechanical devices and fortifications, together with biographical and political notes. Prof. De Toni has already communicated an outline of his results to the *Comptes rendus* of the Paris Academy of Sciences (vol. 173, No. 15, October 10, 1921, pp. 618–20). Further more detailed communications by him will appear in the publications of the Instituto Reale of Florence.

AT a joint meeting of the Royal Geographical Society and the Alpine Club on December 20 Col. Howard Bury gave an account of the work of the Mount Everest Expedition. He was followed by Mr. Mallory, who is again to take part in next year's assault on the summit. Mr. Mallory described the conditions which the climber will probably have to face and discussed the possibilities of success. The summit of the mountain is formed by three arêtes. The faces between them are quite impracticable, and the only possible line of advance seems to be to reach the upper part of the north-east arête from the north. Whether it is possible on account of reduced atmospheric pressure to reach the summit is another matter, and on this point Mr. Mallory spoke with caution. He believed it possible for unladen mountaineers to reach 26,000 ft., and did not think the last 3000 ft. would be so much more tiring as to exclude the possibility of reaching the summit. The higher one goes the less is the effect of any given rise, since the atmospheric pressure diminishes less rapidly

at increasing heights. On the other hand, Mr. Mallory pointed out that descent is definitely an exertion and means growing fatigue even on gentle slopes, and this was particularly noticeable in the case of the coolies, probably because few of them had learned how to husband their strength. Prolonged exertion at the highest altitude reached, about 23,000 ft., necessitated long rest; this problem will increase the difficulty of the last stages. And if anyone fails towards the summit he will require to be sent down with an escort—a contingency which may be likely to occur and will undoubtedly hamper the prospect of success. Mr. Mallory believes that the chances of success for any particular party are small, but that if the attempt were made year after year the summit eventually could be reached.

THE University of Calcutta has published a useful pamphlet, a translation from the Italian of "The First Outlines of a Systematic Anthropology of Asia," by Prof. V. Giuffrida-Ruggeri, of the Royal University of Naples. It gives a useful summary, with references to authorities and statements of physical measurements, of the most recent work on this subject. It is a welcome indication of the progress of anthropological studies in India that a work of this kind should be appreciated by the authorities of Calcutta University.

MALACOLOGISTS will welcome the appearance, after an interval of more than four years, of another part (No. 24) of the "Monograph of the Land and Freshwater Mollusca of the British Isles," by Mr. J. W. Taylor, of Leeds. The first part of this great work, which is probably the most complete account of any faunal group, was published as long ago as 1894, and its progress since the completion of the third volume in 1914 has been much too slow. The present instalment contains the beginning of the Xerophila group of the Helicidæ, and in text, plain and coloured illustrations, distribution maps, portraits, etc., is fully up to the high standard which is characteristic of the work. All who are interested in the mollusca will wish the author more speedy progress with the rest of his undertaking.

ENTOMOLOGICAL BULLETIN No. 964 issued by the United States Department of Agriculture is devoted to the garden flea-hopper (*Halicus citri*) and its control. This insect is a striking form belonging to the family Capsidæ, and although the male is winged the female is of a different form and generally totally wingless. Leguminous plants appear to constitute its favourite food, and both the adult and young insects suck the sap from punctures which they make in the tissues. Discoloration and wilting are the symptoms produced, and in severe cases of infestation death supervenes. Clean cultivation in order to prevent the hibernation of the insect in weeds was found to result favourably in reducing the numbers of the pest, and is regarded as the most adequate controlling measure so far devised.

IN a paper of unusual interest in the *Journal of Genetics*, vol. 11, No. 2, Miss I. Leitch gives an account of breeding experiments with some of the Princess Beans of Prof. Johannsen. The latter described a mutation having longer seeds, which arose in one of his pure lines, and bred true, showing it to have been homozygous at the time of its origin. This long mutant (M) has now been crossed with its parent form (E). The seeds from the cross, containing F_2 embryos in F_1 seed-coats, show curves of distribution for length ranging from below the lowest limits of the pure line E to the upper limit of M. Further experiments show that a definite new type, X, shorter and broader than E, is segregated out from this cross. The hybrids either split into M, X, and an intermediate type which goes on segregating, or they do not split at all; and the ratios indicate that a simple Mendelian difference is involved between M and E. The mutant type is found to differ not only in length of seed, but also in producing fewer seeds, and in being more liable to fungus attack. It is pointed out that the theory of loss of factors does not account for the nature of this mutation, and it is suggested that the absence of segregation, as described in certain cases, may have a cytological basis.

THE extensive series of memoirs brought together by Dr. Emil Abderhalden under the title of "Handbuch der biologischen Arbeitsmethoden" includes, as Abteilung 10, Heft 2, an illustrated work by O. Abel, of Vienna, on the methods of palæobiological research (Urban and Schwarzenberg, Berlin, 1921, 30 marks). The external forms, adapted for special modes of life, exhibited by living animals are freely used as aids in restoring fossil remains. Striking examples of convergence are also given, where similarity of habit has induced an external similarity which might easily mislead where hard parts are alone preserved. Heilmann's walking Archæopteryx, compared with the dinosaur Ornitholestes, is interestingly reproduced, but is surpassed by the author's own reconstruction of a pterodactyl on a branch in the attitude of an Indian bat. The appeal throughout is from the fossil to the animate world, and under the influence of these pages we may see Machairodus stealing through our museum corridors, Belemnoids shooting backwards to pierce the entanglement of algæ, and Coccosteus eluding study by a wave of its long-drawn tail. In Lieferung 28, which forms Heft 1 of the same Abteilung, Th. Arldt, of Radeberg, treats of the methods of palæogeography. Palæontology is here called in as an ally, but it must work hand-in-hand with considerations of general geology. None of the published palæographic maps are reproduced, perhaps on account of their lack of resemblance to anything on the earth at the present day. This is, of course, due to our ignorance of topographic details, and the author is modestly content with a general essay on how to approach a very difficult subject.

MR. R. LLOYD PRAEGER'S account of the genus Sedum as found in cultivation, which fills 314 pages of the recent issue of the Journal of the Royal Horticultural Society (vol. 46, May, 1921), will interest the botanist as well as the gardener. The genus is widely spread throughout the northern hemisphere, mainly

in temperate countries or on the mountains in lower latitudes, reaching the equator on the mountains of Central Africa and South America. About 500 species are at present known to the botanist. Mr. Praeger has, to the best of his ability, ransacked the gardens of the world, and has received and grown no less than 151 species, of each of which he gives a full description with a good illustration showing the habit of the plant and structural details of leaf and flower. Of this number only about twenty-seven are usually found in English and Continental gardens, though many of the rarer ones are of considerable interest or beauty. Further, there are great possibilities; among the many hundreds of new plants described in recent years from China, especially from the scarcely accessible western provinces, are at least ninety new species of Sedum which are known almost entirely from dried specimens in the herbarium. Mexico, which is now known to be extraordinarily rich in Sedums, was until recent years a *terra incognita*, and many handsome species are in cultivation at Washington and elsewhere, though almost unknown in European gardens. The Sedums are notorious for the ease with which a scrap will take root and grow; in many species detached leaves will produce a bud and root from their base, which speedily form a new plant. They are also very easy to cultivate, and few plants are better fitted to endure adverse conditions of soil and moisture.

A MAP to show the chief sources of metals in the British Empire with diagrams of production for 1918 has been prepared under the direction of the Mineral Resources Committee of the Imperial Institute (Messrs. G. Philip and Son, 5*s*. 6*d*. net, on paper). The sheet, measuring 35 × 44 in., contains a map of the world, excluding high latitudes, on Gall's projection, a number of inset maps, and diagrams of output for the chief metals and metallic ores. It is executed on a bold scale with a view to its utilisation as a wall-map for reference and educational purposes. One striking effect of the diagrams is to make it evident that, except in respect of gold, nickel, and perhaps tin, the British Empire output of no metal amounts to 50 per cent. of the world's output; in many cases the proportion is much lower. It is a pity that the figures for a more normal year could not have been utilised.

CAPT. J. B. L. NOEL has recently laid before the Royal Geographical Society some notes from his own experience on the photographic equipment and methods of work for travellers. These notes are offered as an addition to the instructions already contained in the society's "Hints for Travellers," and are well worth the study of anyone interested in the subject. For general purposes he advocates a quarter-plate camera, made of metal if possible, but otherwise well brass-bound, as giving better results with modern anastigmats and later enlargement to whole-plate size, than photographs of this size taken direct, with a great saving in both portability and rapidity of action. The tripod, however, should be as constructed for whole-plate cameras, and may easily be provided with an azimuth circle and compass. The lens should be a convertible anastigmat with a between-lens shutter. For special "instantaneous" photography the reflex camera is replaced by a vest-pocket fixed-focus camera, which is the acme of portability and simplicity. The author deals also with orthochromatic modifications, kinematography, and sundry other matters. "Development," he says, "should always be carried out in the field within about fourteen days of exposure, and within six days in tropical countries."

LONG-RANGE forecasts issued officially in the early part of the autumn have, beyond doubt, been most thoroughly appreciated by the general public. The forecasts, issued on September 26 and 28, scarcely surprised those who have carefully watched the progress made by the Meteorological Office in recent years, although the venture was bold. The *Meteorological Magazine* for November contains an explanation of the long-range forecasts made, and deals with the weather conditions which led to the forecast, giving in detail the weather which followed. The circumstances are set out by Mr. E. V. Newnham, who is engaged in the Forecast Branch of the Meteorological Office. An anticyclone was centred over the British Isles and low-pressure systems existed over Iceland as well as in Scandinavia and in the neighbourhood of the Azores. The occasions of similar conditions in September were tabulated for several years, and the duration of later fine weather was noted for stations in England south of the Mersey and Humber. The time elapsing before the complete break up of the fine spell over eastern England was only in one instance less than a fortnight. In the recent September long-range forecasts there was a temporary break in the south-west in some places on the seventh and eighth days. In northern England appreciable rain fell on the eighth and ninth days. Over eastern and central England south of the Humber a definite break-up had not occurred on October 14. The ten-day forecast issued on September 26 for the southern half of the kingdom was not altogether a success, but the fourteen-day forecast for the eastern and central parts of England issued on September 28 was decidedly successful. Beyond doubt similar forecasts will be made in the future as opportunity is afforded.

"THE British Journal Photographic Almanac" makes its appearance as usual, and continues to be the indispensable book of reference for all who are in any way concerned with the practice of photography. The editor has few notable departures to chronicle for the past year. The chief of those mentioned is the process of desensitising exposed plates so that development may be carried on in a much brighter light than is otherwise permissible. In the "Epitome of Progress" attention is directed chiefly to practical details, as the more strictly scientific matters are now being systematically recorded in "Photographic Abstracts" prepared by the Scientific and Technical Group of the Royal Photographic Society. We congratulate the editor on his "History in Brief of Photographic and Photo-mechanical Pro-

cesses," for no one can properly appreciate any subject unless he is acquainted with at least the outlines of its history. The tables given in this almanac are so numerous that some of the older ones have occasionally to be omitted to make room for others, but the omission is largely compensated for by a list of those not included, with the most recent year of the almanac in which each may be found.

A CHEMICAL examination of a Babylonian glass vase of a date approximately 1000 B.C. is described in the *Chemiker Zeitung* of November 15 by Dr. F. Rathgen. It appears to have been formed by the application of soft glass to the outside of a clay shape, and has been but little attacked by the soil-water. The glass was white and opaque, the presence of microscopic white fused spherules being observed. Analysis gave silica, 73·32; alumina, and ferric oxide, 11·78; calcium oxide, 5·86; potassium and sodium oxides, 4·46; and cupric oxide, 3·88. The vase was decorated by oval to circular lenticular pieces of glass fused on the body. A piece of magnesite from the same period showed borings which indicate the use of a tubular boring instrument with the addition of an abrasive, possibly quartz. Such instruments, belonging to the Neolithic period, have previously been described. A finger-ring of metallic tin is also referred to. A method of detecting indigo in coloured fabrics, depending on its sublimation in a current of carbon dioxide at 230° C., showed its presence in the garment of an Egyptian princess of the year 1000 B.C.. *Indigofera argentea* occurs in Egypt.

GENERALLY speaking it is found more economical to utilise the whole of the available head in a reservoir system intended for domestic water supply to overcome the frictional resistance in the supply mains, rather than to attempt to use it also as a source of power. Occasionally, however, where multiple reservoirs are used, and where these are at different elevations, or where a constant flow of compensation water is available, it is possible to develop an appreciable amount of power at the expense of a head which would otherwise be wasted. An interesting example of this is to be found in connection with the waterworks of the Bradford Corporation in the higher reaches of the Nidd. Here advantage has been taken of an existing high-level reservoir at the head of the Nidd Valley. The new reservoir is now under construction at a lower level, and the discharge from the higher reservoir is being utilised to drive a hydro-electric plant, which will supply the power required for operating the ropeways, cranes, crushers, and other machines required for the building of the dam, and for lighting the improvised village where the workers will live. The power-house contains two 300 h.p. turbines, each directly coupled to a three-phase alternator of 200 kw. capacity at 2200 to 2400 volts. Messrs. Vickers, Ltd., have been responsible for the construction of the hydro-electric scheme.

Our Astronomical Column.

THE JANUARY METEORS.—Mr. W. F. Denning writes:—"The opening nights of every New Year are marked by an abundance of meteors, though they vary in number at different returns, and are sometimes altogether obscured by clouds. The best time to look for them at their next appearance will be in the two hours preceding 7 a.m. on January 4, but they may also be plentiful on the morning and evening of January 3. This particular shower furnishes conspicuous objects with long flights of moderate speed. The radiant point is usually in 230°+54°, and this is near the northern horizon at about 8.30 p.m. An hour before sunrise, however, the position is high in the north-east and situated far more favourably for the distribution of meteors.

"This particular system has not been hitherto associated with any known comet, but it is highly probable that it is connected with some body of this kind which existed in past times, and possibly exists to-day."

The shower appears to have become definitely visible at an earlier period than usual at this return.

On December 20 a bright meteor was seen by Miss Cook at Stowmarket and by Mr. F. Sargent at the University Observatory, Durham. A comparison of the recorded paths indicates the radiant point at 229°+60° and the height of the object from 72 to 55 miles over the region of Surrey.

On December 23 several meteors, including a brilliant one at 8 p.m., were observed from Bristol from the same shower, and there seems no doubt that the display of Quadrantids is prolonged over a rather considerable period, though it furnishes a really abundant display over a few hours only.

THE FURTHEST CLUSTER.—The cluster N.G.C. 7006 has the distinction of being the most remote celestial object of which the distance has been determined in a manner that inspires some confidence. Dr. Harlow Shapley and Miss B. W. Mayberry contribute an article on it in Proc. Nat. Acad. Sci., May, 1921. It is on a line from α to γ Delphini, prolonged to twice the distance between them. The distance in kiloparsecs by five independent methods is given as follows:—

Distance kp.	Method.
67	Parallax-diameter correlation.
71	Photog. magnitude brightest 25 stars.
62	Photo-vis. magnitude brightest 38 stars.
63	Integrated visual magnitude.
69	Median magnitude of 11 Cepheids.

The mean of all the methods gives 66·4 kiloparsecs, or 217 thousands of light-years.

The first and fourth methods have little *a priori* weight, and are merely used because experience shows that the linear magnitudes and absolute luminosities of globular clusters vary only between narrow limits.

In the fifth method the measured median magnitude is 18·96, and the assumed absolute magnitude is −0·23, derived from the study of similar stars in other clusters.

The assumption that there is no sensible absorption of light in the intervening space is supported by the fact that the colour indices of the brighter stars are quite comparable with those of stars in the sun's neighbourhood. Absorption would tend to make them redder.

Prize Awards of the Paris Academy of Sciences for 1921.

AT the annual public meeting of the Paris Academy of Sciences the prizes and grants for 1921 were awarded as follows:—

Mathematics.—The Francœur prize to René Baire, for his work on the general theory of functions; the Bordin prize was not awarded, as no memoir on the question set was received.

Mechanics.—The Montyon prize to Edmond Fouché, for his studies on the theory of rectifying columns in fractional distillation; the Poncelet prize to Emile Jouguet, for his work as a whole; the Boileau prize to Edmond Maillet, for his work on subterranean and fluvial hydraulics; the Pierson-Perrin prize between Jean Aubert, for his work entitled "Probability in Shooting in War," Denis Eydoux, for his works on general and applied hydraulics, and Albert Thuloup, for his works on the resistance of materials and his study on elastic doublets.

Astronomy.—The Lalande prize to Paul Stroobant, for the whole of his work in astronomy; the Benjamin Valz prize to Jean Trousset, for his experimental work on double stars and the errors of divided circles, and for his studies on the eighth satellite of Jupiter and the moon's motion; the G. de Pontécoulant prize to A. C. D. Crommelin, for his astronomical work as a whole.

Geography.—The Gay prize to Georges Perrier, for his work in geodesy, especially in connection with the measurement of an arc of meridian in equatorial America. In the absence of candidates fulfilling the very special conditions of the founder, the Tchihatchef foundation is not awarded.

Navigation.—The prize of 6000 francs between William Loth (4000 francs), for his inventions connected with navigation, especially for his method of guiding ships into ports, and René Mesny (2000 francs), for his work on radiogoniometry; the Plumey prize to Paul Dumanois, for his memoir on the determination of a criterion of general fatigue of internal combustion motors.

Physics.—The Gaston Planté prize to Cyrille Guilbert, for the whole of his work on electricity; the Hébert prize to Jean Baptiste Pomey, for his books on electrical theory and wireless telegraphy and telephony; the Henri de Parville prize to Paul de la Gorce, for his experimental researches on the electrochemical equivalent of silver, testing of dielectrics, photometry of electric lamps, and the determination of the harmonics of an alternating current; the Hughes prize to Joseph Bethenod, for his work in wireless telegraphy; the Clément Félix foundation to Maurice de Broglie, for the continuation of his researches on the X-rays.

Chemistry.—The Montyon prize (Unhealthy Trades) to the late Lucien Ville (2500 francs), for his work on poison gas; Jean Pougnet receives an honourable mention (1500 francs), for his contribution to the chemical study from the manufacturing point of view of some chemical war products; the Jecker prize to Jean Eugène Léger, for his researches on organic chemistry; the Cahours foundation, encouragements of 1500 francs to Charles Courtot, for his researches on the fulvene series, and to Charles Dufraisse, for his work on ethylenic stereoisomerism; the Berthelot prize to Mme. Ramart-Lucas, for her work in organic chemistry; the Houzeau prize to Pierre Jolibois, for his researches in inorganic and physical chemistry.

Mineralogy and Geology.—The Cuvier prize to Alexandr Petrovič Karpinskii, for his work in palæontology and geology; the Delesse prize to Lucien Mayet, for his geological work; the Victor Raulin prize to Louis Mengaud, for his memoir, "Recherches géologiques dans la région cantabrique"; the Joseph Labbe prize to Edouard Alfred Martel, for his new treatise on subterranean water.

Botany.—The Desmazières prize to Robert Douin, for his researches on the Marchantia; the Montagne prize between René Maire (1000 francs), for his work on the mycological flora of northern Africa, and G. Bioret (500 francs), for his memoir entitled "Le développement et la biologie des graphidées corticoles"; the Thore prize to Samuel Buchet, for his researches on the Myxomycetes of France; the de Coincy prize to Henri Chermezon, for the whole of his botanical researches; the Jean de Rufz de Lavison prize to Raoul Cerighelli, for his memoir on root respiration and the application of these researches to the influence of the soil on vegetation.

Anatomy and Zoology.—The Da Gama Machado prize to Jean Verne, for his studies on the pigments of the decapod crustacea; the Savigny prize to Armand Krempf, for his researches on the growth of coral.

Medicine and Surgery.—Montyon prizes to Emile Roubaud (2500 francs), for his work relating to paludism in France, Célestin Sieur and Raoul Mercier (2500 francs), for their memoir on "Le service de santé du groupe d'armées Fayolle en 1918," and Edouard Bourdelle (2500 francs), for his book on the regional anatomy of the domestic animals, part 3, the pig. Honourable mentions (1500 francs) to Edouard Antoine, for his work entitled "Les rectocolites graves"; Marc Rubinstein, for his practical treatise of serology and serodiagnosis; and Arthur Vernes, for his atlas of syphilimetry. Citations to Jacques Carles, for his work "La dysenterie amibienne et les entérites chroniques de guerre"; to Fernand Masmonteil, for his memoir "Des fractures diaphysaires de l'avant-bras"; to Pierre Menard, for his mercury sphygmo-manometer; and to Henri Velu, for his work on Moroccan veterinary pathology. An encouragement (1000 francs) to Mlle. Augustine Forget ("Barria"), founder and director of *La rééducation de la parole*; the Barbier prize to Ernest Sacquépée, for his researches on gas gangrene; the Bréant prize (5000 francs accumulated interest) to Edouard Dujardin-Beaumetz and Edouard Joltrain, for their work in connection with an outbreak of bubonic plague; the Godard prize to Xavier Delore and André Chalier, for their memoir on congenital tuberculosis; the Mège prize is not awarded; the Bellion prize equally between Etienne Ginestous, for his practical treatise of ocular hygiene, and Georges Rosenthal, for his work on tracheo-fistulisation; the Baron Larrey prize to Georges Ferry, for his memoir on aviators' disease; the Argut prize to François Foveau de Courmelles, for his work on radium and X-rays in connection with gynæcology.

Physiology.—The Montyon prize to Henri Piéron, for his work on the reflexes; the Lallemand prize to Georges Guillain and Alexandre Barré, for their book, "Travaux neurologiques de guerre"; the Philipeaux prize to Edouard Grynfeltt, for the whole of his work on the anatomy and physiology of the vertebrate eye; the Fanny Emden prize is not awarded.

Statistics.—The Montyon prize to Gabriel Letainturier, for a book entitled "Two Years' Work in the Yonne during the War."

History and Philosophy of Science.—The Binoux prize to Alfred Rouxeau, for two books entitled

"Laënnec before 1806" and "Laënnec after 1806."

Medals.—The Arago medal to Auguste Pavie, for the eminent services which he has rendered to science and to France by his explorations in Indo-China.

General Prizes.—Prize founded by the State: Grand prize of the physical sciences. No memoir was received on the subject set, but two honourable mentions (1500 francs each) are awarded to Paul Honoré Fritel, for his works on the palæobotany of the Paris Tertiary, and to Pierre Marty, for his researches on the fossil flora of the Cantal. The Petit d'Ormoy prize (pure and applied mathematics) to the late George Humbert, for his work as a whole; the Petit d'Ormoy prize (natural science) to Marcellin Boule, for the whole of his work in palæontology; the Le Conte prize to Georges Claude, for his numerous inventions and applications of science to industry; the Jean Reynaud prize to the late Yves Delage, for the whole of his scientific work; the Baron Joest prize to Jacques Duclaux, for his researches and memoirs on colloids; the Parkin prize to Fernand de Montessus de Ballore, for his work in seismology; the Saintour prize to Pierre Boutroux, for his work in mathematics and the history and philosophy of science; the Henri de Parville prize to Camille Martinot Lagarde, for his publications on aviation motors; the Lonchampt prize to Augustin Damiens, for his researches on the bromine existing normally in animal tissues; the Wilde prize to Ferdinand Canu, for his study of the fossil bryozoa; the Gustave Roux prize to Louis Eblé, for his meteorological work; the Thorlet prize to Adolphe Richard, for his work in bibliography.

Special Foundations.—The Lannelongue foundation (accumulated interest) between Mmes. Cusco and Rück.

The Laplace prize to Pierre René Ricard and Jean Louis Joseph Edmond Berthelot; the L. E. Rivot prize to Pierre René Ricard (750 francs), Jean Louis Joseph Edmond Berthelot (750 francs), Michel Raymond Hippolyte Clovis Duhameaux (500 francs), Pierre Jules Lion (500 francs), Jean Pierre Paul Chapouthier (750 francs), Jean Gustave Marie de Sèze (750 francs), Jean Emile Lecoannet (500 francs), and Gaston Albert Oudotte (500 francs).

The Trémont prize (1000 francs) to Louis P. Clerc, for his work entitled "The Applications of Aerial Photography"; the Gegner foundation (arrears of interest) to Ernest Lebon; the Henri Becquerel prize to Camille Flammarion, for the whole of his work; the Charles Bouchard foundation to Maxime Ménard, for his work in radiography.

The Bonaparte Foundation.—The committee has examined twelve applications for grants from this fund and recommend the following:—(1) 2000 francs to Fernand Blanchet, for his researches on the detailed geological structure of the Escreins massif (High Alps); (2) 10,000 francs to the Fédération française des Sociétés des Sciences naturelles, as a contribution to the publication of the "Faune de France."

The Loutreuil Foundation.—(1) Grants to establishments mentioned by the founder:—

National Museum of Natural History.—6000 francs to Paul Lemoine, for geological researches on the Paris basin. 2000 francs to Ferdinand Le Cerf, to assist him in pursuing his researches on the Ægeriidæ by the study of the collections in England.

National Veterinary School at Lyons.—2000 francs to this establishment for completing the grant made in 1918 for the purchase and installation of a kinematograph for teaching purposes. 2000 francs to François Maignon, for his researches on opotherapy and avitaminosis. 1500 francs to Armand Porcherel, for his studies on mules.

National Veterinary School of Toulouse.—3000 francs to Jean Sendrail, André Martin, and Robert Lasserre, for their researches on various parasites of the Toulouse region and the diseases caused by them. 1500 francs to Charles Hervieux, for his studies on the transformation of chlorophyll in animals.

(2) Grant accorded to establishments called to the committee of the foundation by the President of the Institute:—

Conservatoire national des Arts et Métiers.—3000 francs to Léon Guillet, for an installation for the study of magnetism and the examination of metal fractures.

(3) Grants made on direct application:—

6000 francs to Louis Bazy, for his researches on the application to surgery of the data acquired in general bacteriology.

2000 francs to Louis Bedel, for the study of the fauna of the Seine basin.

5000 francs to the Société des Amis du Laboratoire des Essais méchaniques et métallurgiques de Grenoble, to contribute to the organisation of a laboratory.

3000 francs to the *Journal des Observateurs.*

2500 francs to Jean Charcot, for the purchase of instruments to be placed on ships in the Navy in view of oceanographic researches.

5000 francs to Henri Deslandres, for his studies on the ionisation of the air.

6000 francs to the École supérieure d'Aéronautique et de Construction méchanique, for the purchase of a Le Chatelier apparatus required for the micrographic study of metals.

10,000 francs to the Fédération française des Sociétés des Sciences naturelles, for the publication of the "Faune de France."

8000 francs to the Institut agricole de Beauvais, to develop agricultural experiments.

4000 francs to the Institut industriel du nord de la France, to improve the scientific equipment of this establishment.

3000 francs to Armand Lambert, for the revision of the calculations of the catalogue of fundamental stars.

10,000 francs to the Observatory of Ksara, to enable it to resume its normal working.

5000 francs to the Société de Géographie, for the publication of various maps.

15,000 francs to the Académie des Sciences, for printing the catalogue of the inventory of the scientific periodicals of Paris.

Anthropology at the British Association.

SECTION H (Anthropology) met under the presidency of the Right Hon. Lord Abercromby, Sir James Frazer, who had been announced to preside, finding himself unable to attend the meeting. Owing to the late date of Lord Abercromby's acceptance of office he had had no opportunity to prepare an address, and the sectional programme consequently lacked this important item, upon which the success of the sectional proceedings largely depends. Notwithstanding this unfortunate omission, a full and interesting programme attracted good audiences and gave rise to much valuable discussion.

Of the three organised discussions included in the programme reference has already been made in these columns to two, namely, Sir Richard Temple's appeal for an Imperial School of Applied Anthropology and

the discussion on "The Origin of the Scottish People," held in joint session with Section E (Geography). The third discussion—on totemism—was initiated by Sir William Ridgeway. He said that some years ago he had pointed out that vegetation spirits and totemic beliefs were secondary to a primary belief in the continued existence of the soul after death and in its transmigration. The sacredness of certain rocks, trees, plants, and the like depended upon the belief that they were the abode of the spirits of those who were buried under or near them or were killed near them. Totemism arose from a like belief. The bodies of the dead were left to be devoured by wild beasts, and it was believed that the spirits inhabited their devourers. In other cases it was still believed that the spirits of the dead entered or dwelt in certain animals or trees. Sir William Ridgeway's theories appeared to be generally acceptable to his hearers with the exception of Dr. Hartland, who, without entering into a detailed discussion of the evidence in support of the theory, pointed out that it made totemism later than, and dependent upon, the belief in the immortality of the soul, which is not a primary or fundamental belief in primitive religion. On the other hand, Dr. Rivers gave wholehearted support to Sir William Ridgeway's view, laying particular stress upon the element of reincarnation. Totemic peoples were averse from eating their totem, as it would be cannibalism. The strong impression made upon the community by the personality of the ancestor with whom the totemic cult originated suggested that he was the representative of a higher culture coming from outside the community. Dr. Haddon suggested that the hero-cult of Eddystone Island, which had been mentioned as cutting across the totemic cult, was probably a graft on an earlier hero- or ancestor-cult. Dr. Donald MacKenzie pointed out that beliefs connected with holy trees and other objects did not necessarily connote a totemic belief, and Mr. H. A. Migeod referred to the absence of totemism among the peoples of West Africa.

Among other ethnographical papers considerable interest attached to the two communications by the Rev. J. Roscoe, dealing with work of the Mackie Ethnological Expedition to Uganda. Of these, one gave a popular summary of the results of investigations among the peoples of Ankole and Bunyoro, and described in detail the milk ceremonial of the dominant pastoral tribes. He suggested that these peoples may be connected with the Galla, and through them with ancient Egypt. Wherever they are found they are the dominant race, having subdued and enslaved the aborigines. In some districts they avoid intermarriage, and the two clearly differentiated races are found side by side. The expedition had succeeded in finding a line of demarcation between the pastoral people of the Lake region and the Somali, Nandi, and Masai tribes, who are of the same origin. In his second paper Mr. Roscoe dealt with the death ceremonies of the tribes of the Lake region, which are based upon the belief in ghosts—the only supernatural being in which the native believed. The Bagesu are ceremonial cannibals, and eat their dead lest the ghost do harm to the young people of the family. In Ankole, Bunyoro, and Buganda the ghosts are propitiated by various forms of offering. An important paper by Mr. T. F. McIlwraith also dealt with African death rites. As the result of an analysis of the ceremonial of West Africa and the Congo, he suggested that the sporadic custom of preserving the bodies of chiefs, combined with the occasional use of a coffin, the anthropomorphic figure, and sometimes the use of representations of the deceased, point to the possibility of influence from ancient Egypt, which may have spread inland from the coast; this would account for the absence of similar practices in East Africa. If, however, the diffusion took place by land, their absence in that area would be due to the influx of the pastoral tribes. An interesting paper by Mr. F. W. H. Migeod dealt with the ceremonial avoidance of contact with the ground as practised in different parts of Africa on a variety of occasions. The author was not, however, able to suggest any one general reason for the practice. A communication presented on behalf of Mr. M. W. Hilton-Simpson described a primitive "water-clock" in the form of a bowl in use among the Shawia of Algeria. In the bottom of the bowl is a hole through which water penetrates until the bowl fills and sinks. This "clock" is used in connection with the regulations of the water-supply for irrigation; each landowner is entitled to a definite number of "sinkings," after which the water is turned off. The bowls, which are the property of the community, are now often made of zinc, but old specimens are of beaten copper. The author attributed a considerable antiquity to this method of time-measurement.

Dr. W. H. R. Rivers described the Melanesian system of land tenure, with special reference to the customs of Ambrim and Eddystone Island. In the patrilineal societies of these islands the system of land tenure is essentially communistic, and agrees with the type of tenure found in the matrilineal parts of the archipelago. On the other hand, ownership of trees may be assigned to individuals by a religious ceremony, and is distinct from ownership of the land. Dr. Rivers held that the system was a compromise-formation between the communism of the indigenous population and the individualism of immigrants. Mr. Lewis Spence discussed the sources of our knowledge of the religion of ancient Mexico.

Aspects of Scottish folk-lore formed the subject of two communications. Canon J. A. MacCulloch dealt with the attitude of sixteenth- and seventeenth-century folk-lore to fairies and witches, attributing the common ban which the people placed upon fairies and witches alike to the ecclesiastical attitude which regarded them both as equally connected with the powers of darkness; and Dr. Donald MacKenzie discussed the peculiar features of Scottish folk-lore, with special reference to its differences from that of Ireland, and the evidence which, in his opinion, it exhibited of culture drifting. It is interesting to note that whereas pork was eaten freely in Ireland from the dawn of history, it was, and in certain localities still is, tabu in Scotland.

Apart from the discussion on "The Origin of the Scottish People," only two communications dealt with the physical side of the science, but both these were of considerable interest. Dr. Nelson Annandale exhibited photographs of physical types, part of a series which had been formed in the Zoological Department of the Indian Museum at Calcutta, and suggested the institution of similar series in other localities for educational and scientific purposes; and Miss Fleming discussed the necessity for recognising modifications in the standards of race distinction in the case of women, particularly in connection with the ages at which alterations take place in skull form, in the shape of the head, and in coloration.

The archæological papers presented to the section, as is usual, attracted considerable attention, and with good reason. Prof. Baldwin Brown, in a paper of a more philosophic type than is common in the proceedings of the section, discussed the *rationale* of primitive art, with special reference to recent discoveries, and pointed out that, being of practical use to

the individual and the race, it was, in a sense, forced on them. It was thus in conflict with the idea of the freedom of artistic activity—the corner-stone of current artistic theory. Mr. Miles Burkitt described the new painting of Palæolithic age found in the Pyrenean cave of Trois Frères. The painting portrays a number of animals arranged as a frieze and the figure of a masked man with stag's antlers on his head and with a tail which the author compared with the early Gallic god, always shown as masked, and the Cretan god of Minoan times. This figure elicited some interesting remarks from Miss Murray on the possible existence of a witch-cult in Palæolithic times. Mr. Leslie Armstrong exhibited a reproduction of the engraved flint found last year at Grime's Graves.

As a preliminary to the excursion made by members of the section to the excavations on Traprain Law, Mr. Alex. O. Curle gave an account of the earthworks and settlements on this site, and described the magnificent hoard of fourth-century silver plate discovered there and believed to have formed part of the booty pillaged by Saxon pirates from Gaul.

Among other communications on archæological subjects mention must be made of Miss Murray's account of her investigations in Malta, which brought to light the site of a megalithic temple at Boy en Nadur, on the Bay of Marsa Scirocco, and Dr. T. Ashby's account of the year's work in Italy and Tunisia, which has given us, particularly at Ostia and Pompeii, much fresh evidence as to Roman domestic architecture. Mr. J. Whatmough dealt with the functions of the Rehtia, the Venetic goddess of healing, suggesting that the so-called "nails" and "wedges" associated with the cult are to be explained as a specialised type of votive hair-pins with pendant axe-shaped talismans.

Mr. Stanley Casson gave a descriptive account of a journey through Macedonia undertaken under the auspices of a committee of the Association with a view to archæological investigation. Excavations of a cemetery at Chauchitsa produced a large number of objects of the Iron age, including bronze ornaments, pottery, hand- and wheel-made, some gold, and a little iron. These finds throw an interesting light upon the culture of Macedonia and its relations with Greece at this period.

Valency Bonds and the Mechanism of Organic Reactions.

IN recent years the significance of the conventional bond in the structural formulæ of organic compounds has been the subject of much speculation, more particularly in reference to the view that the bond corresponds with the field between two opposite electrical charges associated with the chemically combined atoms. The electrical conception of the valency bond has been further developed in a very interesting manner by Prof. A. Lapworth (Manchester Memoirs, vol. 64, No. 3, 1920) with the object of explaining the mechanism of the reactions of organic compounds.

Certain reactions, such, for example, as those of carbonyl compounds with electrolytes, suggest that the carbon atom of the carbonyl group is more electropositive than the oxygen atom of this group, in that the carbon atom invariably enters into combination with the negative ion. The relative polar character which the two atoms seem to display at the moment of chemical change may thus be indicated by ascribing + and − signs to the carbon and oxygen atoms respectively. Other reactions—for example, the aldol reaction—suggest that the hydrogen atom in the group :CH·CO· is positive relatively to the carbon atom with which it is in combination, and it would therefore seem that the group in question can be represented by the formula

$$\overset{\vee}{\underset{+}{H}}\cdot\overset{\mathrm{I}}{\underset{-}{C}}\cdot\overset{\cdot\cdot}{\underset{-}{C}}\cdot\underset{-}{O}$$

in which the contiguous carbon atoms have opposite polarities. There is a good deal of evidence in favour of the existence of such latent polarisation in pairs of contiguous carbon atoms, and of the view that the carbonyl group tends to develop alternate negative and positive polarities in all the carbon atoms of any chain with which the carbonyl group is associated.

Similar effects are produced by the $\cdot NO_2$, $\cdot SO_2\cdot$, and ·CN groups, and it would seem that the divalent oxygen and tervalent nitrogen atoms are the directing or "key atoms" to which the development of the alternating latent polarisation is to be referred. The halogens are much less effective than oxygen and nitrogen, whilst hydrogen apparently exercises a perceptible influence of the opposite kind.

The extension of the influence of the "key atom" over any considerable range seems to require for its fullest display the presence of double bonds, usually in conjugated positions. The conjugated structure of aromatic compounds affords ample scope for the directing influence of the "key atom," and the behaviour of aromatic compounds is quite in accordance with the predictions of the underlying general principle to which Lapworth has given the name of the "principle of induced latent polarities." It is shown that this principle affords a very plausible explanation of many groups of well-known reactions.

The mechanism of organic reactions is also dealt with in the same volume (No. 4) by Prof. R. Robinson in a paper on "The Conjugation of Partial Valencies." The views put forward by this author have a close connection with the above theory of the development of latent atomic polarisation by induction. It is assumed that reactive (activated) molecules are those in which a rearrangement of valencies or a change in the position of the electrons has taken place. Such rearrangement or change in position is synonymous with the development of partial valencies. To illustrate by a simple example, it is suggested that whereas the normal molecule of hydrogen chloride is represented by the formula H·Cl, the activated molecule is symbolised by $\cdot\underset{+}{\cdot}\cdot H\cdots Cl\cdot\underset{-}{\cdot}\cdot$, in which the dotted lines represent partial valencies of which that of hydrogen is positive and that of chlorine is negative. The author shows that the mechanism of many important reactions can be readily interpreted in terms of such activated molecules. In particular, mention may be made of the phenomena of conjugation, the representation of which is considerably simplified, whilst at the same time the conception of a conjugated system is widely extended. From the author's point of view, conjugation consists, in fact, of the transfer of a free partial valency (or latent polarity) to an adjacent carbon atom or to other carbon atoms more widely removed, and in theory there is no limit to the transmission of reactivity within the limits of the molecular aggregates.

Whether it is preferable to speak of the induction of latent polarisation or the transfer of partial valencies is not a matter of the first importance; it may be taken for granted, however, that the views outlined by Lapworth and Robinson will be of great value in obtaining further insight into the mechanism of the reactions of organic compounds.

H. M. D.

Agriculture in the Maryut District, West of Alexandria.[1]

THE coast district lying to the west of Alexandria and known as Mareotis was well known in Græco-Roman times and for long after for its gardens and vineyards, and even down to the time of the Arab historian Makrisi figs and grapes from there were sold in Alexandria. For several centuries, however, it has been a barren waste except for small patches of barley raised by the nomad Arabs in the more-favoured spots when the winter rains are plentiful. In the report under notice an account is given of an examination made by the Geological Survey and the Ministry of Agriculture of Egypt to determine whether the area offered any prospect of a remunerative return from dry farming or from irrigation by the extension of the westernmost canal of the delta system, the Nubariya.

The district which the report covers is a belt about 15 km. wide on the shore of the Mediterranean, and it extends from Alexandria to a point about 100 km. to the westward. Starting from the sea-shore, there is, first, a series of white dunes formed of small rounded oolitic grains which, by the action of the winter rains, unite to form masses of more compact rock. Behind these dunes, which do not exceed 10 metres in height, is a narrow depression which is of considerable fertility. Farther inland is a higher limestone ridge, where numerous ruins indicate that it was once well populated. The main depression lies behind this ridge, and is about 4 km. wide; figs and barley are cultivated on the slopes on either side of the saline marsh which occupies the central portion of the depression.

The rainfall, which is limited to the months October–March, varies considerably from year to year, ranging from 100–300 mm., and if rain is scanty in November the barley, which is sown as soon as the October rains occur, may yield a very poor crop.

[1] "The Soils and Water Supply of the Maryut District, West of Alexandria." By Dr. W. F. Hume and F. Hughes. (Cairo: Government Press, 1921.)

Full details are given of the physical character of the soil in many parts of the district and at various depths, but what controls all extension of vegetation is the presence of intensely saline water at or near sea-level. On account of this the cultivation of any considerable area is difficult, and the Arabs are able to utilise only the more favoured spots to raise their crops. While it seems probable that about 12,000 acres might be brought under cultivation by the extension of the Nubariya Canal, parts of this area would be too stony for satisfactory cultivation. Generally speaking, a more detailed study of this part, together with more extended contoured surveys, will be necessary before any decision can be reached as to the desirability of irrigation on this part of the desert margin.

A trial of dry farming was made in the Maryut district in the seasons of 1917–18 and 1918–19, but lack of rain in November seriously damaged the crops. The conclusion was reached that such methods are not likely to be successful owing to the variable character of the rainfall and the patchy nature of good soil.

By sinking wells and utilising the winter rainfall fruit-gardens could probably be developed, and this was the principal form of cultivation in ancient times. Over a large area numerous artificial mounds enclose rectangular areas (*karm*), which were certainly at one time gardens. These were watered from wells and from the run-off after winter rains had fallen on the enclosed land and some of the water had been conserved in the central area.

Though the investigation has not led to a prospect of a large extension of Egypt's cultivable area, it has placed our knowledge of the Marvut district on a firm basis, and has shown what developments there are possible. The report is well illustrated by maps and photographs which show the character of this coast region.

Fisheries Biology.[1]

SOME notable papers on marine biology of interest in fishery investigations are contained in the last number of the Journal of the Marine Biological Association. Mr. E. Ford takes up a matter that has hitherto received very little attention—the life-history of the dogfishes. Now that these animals are being utilised as human food (particularly the spur-dog, which enters the markets as "flake") their biology has utilitarian value, and this paper is, therefore, of much interest. The author deals mainly with phases in the reproductive cycles of the common species (the spur-dog, the rough-dog, the nurse-hound, and the sweet-william). The spur-dog and nurse-hound are viviparous, and the prolonged period of incubation *in utero* deduced by Mr. Ford will come as a surprise to most readers; this, in the case of the spur-dog, may extend to twenty-five months. Biologically, the reproductive processes in the dogfishes are of immense interest, and one may hope that Mr. Ford may continue his investigations and give us much needed information as to the natural history and physiology of these animals.

Dr. Marie Lebour continues her well-known work on the food of baby fish. Quite lately this subject has become one of extraordinary importance in fishery investigation, particularly in view of the implications of Dr. Johan Hjort's work on the cod and herring. That there are natural "crises" in the conditions that rule the abundance of sea-fishes is now established, and upon these crises—far more, perhaps, than upon any reasonable variations in the intensity of fishing—depend the quantities of marketable fish present in the sea in any year. There is a short period in the life of the ordinary fish when, its supply of food-yolk being exhausted, suitable pelagic organisms must be found and eaten. The periods of multiplication of the latter are variable, to some extent, from year to year, and so are the spawning periods of the fishes. In some years, therefore, abundant food may be forthcoming just at the time of disappearance of the larval fishes' yolk-sac, but in other years this food may fail, its production occurring well before or after the time when the larval fish transformation occurs in greatest degree. A heavy mortality in the baby fishes must be followed, two or three years later, by a scarcity of the adults, and *vice versa*.

For a proper treatment of this problem we require to know (1) the kinds of food eaten by larval and post-larval fishes, (2) the periods of maximum production of the food, and (3) the maximum spawning periods of the fishes. The first question is being investigated by Dr. Lebour with much success, and in this paper she deals with the food of baby herrings, sprats, and

[1] Journal of the Marine Biological Association, vol. 12, No. 3, Plymouth, September, 1921.

pilchards. The kinds of organisms eaten depend on the phase of the fish—they are larval gastropods, diatoms and flagellates, larval molluscs and crustacea in the case of the herring; green (chlorophyllian) organisms, copepod eggs and larvæ, and copepods (sprat); copepod eggs, larvæ and adults, then mud-containing unicellular organisms, and finally molluscan larvæ in the case of the pilchard. A remarkable result is the great proportion of larval fishes which contain no apparent food, and this observation may lead to most valuable results if it can be shown that there is a correlation between the number of empty stomachs and the poverty of the sea in the necessary food-organisms. In that case we should have an easily observed measure of the coincidence between the period of abundance of larval fishes with that of sufficient food, or *vice versa*, and this is obviously the kind of datum required in order that we may be able to forecast good or bad fishery years. Obviously, the work noticed is of much importance. J. J.

The Need for Research in Colloid Chemistry.[1]

By WILLIAM CLAYTON.

COLLOID chemistry has never been discussed so frequently as it is to-day. Its comparatively recent growth and development, and the fact that its ramifications extend into every field of chemical research and industry, seem to be leading chemists to turn to colloid chemistry as a possible panacea for their numerous and varied difficulties. Certain it is that no branch of applied chemistry to-day can be declared free from colloid problems, and that the chemistry of to-morrow will be colloid chemistry, pure and applied.

Prof. Bancroft's compilation of two hundred research problems adequately serves, not only to demonstrate the wide industrial applications of colloid theory, but also to show the present position of the theoretical science itself with its too frequently purely empirical generalisations. He devotes seventy-one of his problems to a consideration of adsorption phenomena—a correct proportion, no doubt, since adsorption data can be obtained in a very definite *quantitative* way, and the results admit of immediate and varied application.

Adsorption is now recognised as playing a determining influence in heterogeneous catalysis, emulsions, fogs and smokes, surface tension, stability of solutions, coagulation and precipitation, etc. Prof. Bancroft pays particular attention to adsorbed gas films and their influence in contact catalysis. Notable progress in this field has been made by Langmuir in America, who has adduced good evidence that such adsorbed films are of monomolecular thickness. That stable films can exist at atmospheric pressure can be argued from several effects, *e.g.* catalytic poisons, passivity, over-voltage, and lubrication.

Under adsorption Prof. Bancroft details problems in flotation and wetting power, pointing out that no systematic study of the selective adsorption of liquids by solids has yet been published. Quantitative work is urgently needed in this connection, especially as the literature on the flotation of ores contains many papers lacking in sound colloid chemistry.

The caking of powders, setting of cements, behaviour of coarse and fine powders in liquids, and the reversibility of the calomel electrode are a few of the many problems involving adsorption phenomena.

One problem (No. 56) is of outstanding importance, viz. "the quantitative adsorption of dyes by alumina, stannic acid, etc., with special reference to hydrogen-ion concentration." The work of Jacques Loeb on the effect of various electrolytes on gelatin in solutions, with definite hydrion concentrations, has placed the chemistry of gelatin, casein, and other amphoteric proteins on an entirely new footing. Such proteins possess a certain pH value indicating neutrality (gelatin, pH = 4·7). When the pH value exceeds the neutrality figure the protein behaves as an acid, combining with cations; when the pH value is less, the basic tendencies are pronounced and combination with anions occurs. In the light of this work such familiar generalisations as the Hofmeister series of ions or the Pauli series of acids present no real existence, since the pH values were not measured. Membrane permeability, dye-staining, and certain physiological phenomena must all be referred to measured hydrion concentrations.

On the subject of emulsions Prof. Bancroft rightly points out that, whilst the problem of making emulsions has been well investigated, the converse, breaking of emulsions, has not been so thoroughly studied. Stable emulsions are only too frequently a source of great trouble in industrial operations, and work on the theoretical principles involved in devising means for their coagulation or separation is very desirable. In this connection, too, it is pointed out that, in the centrifuging of colloidal systems, no systematic study has been made connecting the quantitative relations between density, size of particles, and number of revolutions per minute necessary to cause precipitation.

Mention is made of the recent work of Holmes and Child, who failed to find evidence for the adsorption of gelatin at the oil-water interface in kerosene/water emulsions. This result contradicts the observation of Winkelblech, who proved that gelatin concentrates at the dineric interface when organic liquids are shaken with water. In any case, the effect of adsorbed films or protective layers of the emulsifying agent in emulsions still leaves much room for inquiry. The old problem of effect of oil concentration on the type of emulsion is brought up once more, Prof. Bancroft doubting the accuracy of Bhatnagar's recent work on the reversal of phases in oil and water emulsions.

A problem of direct industrial importance is referred to in connection with the saponification of fats with lime. It is tentatively put forward that water is the real hydrolysing agent, and that the lime is important because the calcium soap which is formed causes the water to emulsify in the fat, instead of the fat in the water. In this connection it is of interest to refer to Weston's recent work on the use of colloidal clay as an emulsifier-catalyst in the saponification of oils and fats.

Finally, we can only briefly mention one other important field discussed by Prof. Bancroft, viz. the formation and stability of colloids in non-aqueous liquids. The nature of the stabiliser present in such solutions, the peculiar behaviour of the alcohols with silver alcosol, the formation of jellies in organic liquids, the chemistry of the cellulose esters, the behaviour of mixed colloids in non-aqueous solvents—these are but a few of the problems requiring inves-

[1] "Research Problems in Colloid Chemistry." By Wilder D. Bancroft, Member of the Committee on the Chemistry of Colloids: National Research Council. Reprint and Circular Series of the National Research Council (U.S.A.). No. 13 (1921). 50 cents.

tigation and interpretation by modern colloid chemistry. Non-aqueous colloid systems present as yet an almost entirely new field.

Prof. Bancroft has presented in very readable form stimulating problems which should serve to emphasise the growing necessity for the research worker in all branches of chemistry to keep in close touch with the future developments of a branch of his science underlying all industrial chemistry, but which, unfortunately, is not yet sufficiently recognised in the curricula of universities and other institutions possessing honours schools of chemistry.

Orientation in Egypt.[1]

By Col. H. G. Lyons, F.R.S.

MR. RICHARDS'S short note of eleven pages, which has been published by the Survey of Egypt, deals with observations which were made in 1913 and 1914 to determine the azimuth of the axis of Karnak temple. In 1890 Sir Norman Lockyer took some preliminary observations, which suggested to him that the temple at the time of its foundation had been definitely oriented to the sun at sunset at the summer solstice, a conclusion which others made by Mr. Wakefield in 1891, and later by Mr. Howard Payn (NATURE, October 19, 1911) appeared to confirm.

On all these occasions, however, the line of the temple axis was much obstructed by fallen blocks of masonry, and not until 1913 was the clearing so far advanced that satisfactory observations could be made. The results then obtained differed considerably from the earlier ones. As a control the temple axis was carefully surveyed in 1914, and a new determination of the azimuth was then carried out, which fully confirmed that of the year before, namely, 26° 54′ 0″ north of west. The declination of the sun for it to shine down the temple axis must, consequently, be 25° 9′ 55″, instead of 24° 18′ 0″, which the earlier observations had indicated, and the date of foundation deduced therefrom, instead of being 3700 B.C., would be carried back to a time far anterior to the earliest estimate of any Egyptian civilisation. Karnak temple cannot, therefore, be a solar temple having its axis directed to sunset at the summer solstice.

[1] "Note on the Age of the Great Temple of Ammon at Karnak as determined by the Orientation of its Axis." By F. S. Richards. (Cairo Government Press, 1921.)

It had seemed that much support was given to the hypothesis of orientation by inscriptions which definitely describe the foundation ceremony as including the stretching of the measuring cord and the alignment of a peg on a celestial body. But our knowledge of the foundation ceremonial is still incomplete, and it is doubtful if it described a practice which was carefully and accurately carried out at the founding of each new temple; more probably it was a very early rite, which had become purely ceremonial by the time when masonry temples were erected, and when other considerations often influenced the laying out of a site.

At Karnak the axis of the sanctuary, of which the azimuth was determined, was 35·5 metres long, but on account of weathering the centres of various doorways cannot be determined within a centimetre, and an error of 1′ in the azimuth, which may be introduced by this, would alter the date by some 190 years.

Luxor temple has been quoted as a case of a temple in which successive additions were laid out with slightly different azimuths of their axes to compensate for the changing amplitude of the star, which could no longer be seen along the axis of the earlier portion. But Borchardt (*Zeitschrift für aegyptische Sprache*, vol. 34, 1896) has indicated conditions on the site which may equally have necessitated the slight displacements of the later additions, apart from any astronomical considerations. It seems, therefore, unlikely that the foundation dates of Egyptian temples can be determined more accurately from astronomical data than by archæological methods.

Experiments on Plague Eradication in India.

IN "An Experiment in the Eradication of Plague Infection carried out in the Poona and Adjacent Districts: First Report (for the period 1914–16)," and "Further Experiments in Plague Prevention carried out at Poona: Second Report (for the period 1916–18)" (*Indian Journal of Medical Research*, vol. 8, No. 3, January, 1921), Major J. C. G. Kunhardt, I.M.S., and Assistant-Surgeon G. D. Chitre give their experiences as to the possibilities of eradicating plague by rat reduction during the non-epidemic season, and suggest improvements in the methods of rat-destruction.

The basis of the work is the finding of the Plague Research Commission that epidemics of bubonic plague in India may be regarded as entirely dependent on, and perpetuated by, epizootic plague in rats. Hence measures for increasing the immunity of man by inoculation, or for protecting him from infected fleas by evacuation, flea-destruction, etc., could, by themselves, in no way bring about the eradication of the disease from any area; and measures for the eradication of plague infection must depend entirely on the reduction of the rat population. This reduction can be effected indirectly, either by limiting the shelter and food-supply of rats, or by fostering their natural enemies; or directly, by their destruction with traps, poison baits, etc. Practical considerations of several kinds, however, convinced the authors that active rat-destruction was the only available measure.

The method adopted depended on the fact that there is normally, in every year, a season when plague dies down. The new epidemic may be started either through the importation of infection from outside, or through the recrudescence of the disease harboured, though not manifest, in the area itself. In the area selected for experiment—the districts of Poona, Ahmednagar, Satara, and Sholapur—the "off-season" includes April, May and June.

It has been shown that in the great majority of places infection dies out completely before or during the off-season. It may not do so, however, in a large town or village, or one into which infection was first introduced comparatively late in the plague season, since here a number of rats would still be present at the beginning of the off-season, sufficient, sometimes, to enable a rat-epizootic to smoulder on during the unfavourable period. Under the opposite conditions—small town or village, and early introduction—the rat population becomes so reduced by the

time the off-season arrives that infection dies out completely, presumably because the few susceptible rats then surviving are so scattered as to render it difficult or impossible for infected fleas to perpetuate the epizootic by passing from one rat to another.

Now the few towns or villages in which plague infection is likely to persist through the off-season can be detected with a little practice and with the aid of certain "charts"; and the authors' scheme was to reinforce the natural tendency of plague infection to die out by further reducing the rat population in these centres by poisoning or some other means of destruction. Any future epidemics which might occur within the experimental area would then be entirely dependent on re-importation from without.

The experiment was carried out in those places, fifty in number, which were considered likely to carry over the infection from one season to the next (of the 407 places excluded as not likely to carry over, only three, in fact, continued to harbour plague throughout the off-season). The agent of destruction was the "Punjab Rat-exterminator."

Briefly, the experiment was not a success; and since there was practically no failure in "spotting" the places likely to carry over, since, too, the authors are able to conclude that an epidemic of plague in this area is far more dependent on off-season centres of plague infection within the area than on importation of infection from without, it follows that failure was attributable largely to the inadequacy of the methods of rat-destruction.

The authors, therefore, determined to concentrate on the improvement of methods of rat-destruction. Traps were found to vary considerably in efficiency, and can be much improved by attention to certain apparently trivial details of construction. Hydrocyanic acid gas, in general a useful method of destroying rats and their fleas, would be of little practical value for the present purpose unless some method could be devised of rendering Indian houses more airtight while they are being fumigated.

The most efficient and suitable rat poison, of all those experimented with, was barium carbonate. Three grains is a suitable dose; this quantity mixed with four times its weight of food material does not diminish the amount of the latter consumed by the rat; the Punjab rat-exterminator—a phosphorous compound—was, however, found to be actively repulsive to the rat. Barium carbonate, again, was found to be twice as poisonous as the Punjab compound, and a lethal dose costs only one-sixtieth as much as one of the latter substance. Arsenious acid would be the most suitable substitute for the barium carbonate if this were not available. *Bajri* flour is the best vehicle.

The authors' experiments are as yet incomplete, and have, so far, been carried out only in the laboratory; they hope, however, to amplify them and confirm them under more natural conditions. When, armed with their new knowledge, they return to the practical work of rat destruction, we hope that the problem of plague extermination will be advanced one stage nearer a solution.

The Carbonisation of Peat in Vertical Gas Retorts.

THE programme of work undertaken by the Fuel Research Board includes research into the utilisation of machine-won peat, and a report has been issued giving the results of the first series of experiments on the carbonisation of peat in vertical gas retorts with steaming. This material was macerated in 1920, spread on the bog at Turraun, air dried and harvested there, and early in 1921 a hundred tons were sent to the Fuel Research Station, primarily for experiments upon its use in carbonisation and boiler firing.

The peat as received at East Greenwich consisted of hard blocks with a density rather under 1, or about twice that of the ordinary hand-cut sods made on the same bog. The water content, about 25 per cent., was reduced on storage under cover to 17 per cent. These peat blocks are reported to have lent themselves admirably, after suitable treatment, to carbonisation in vertical retorts at temperatures between 750° and 850° C., and also in steel retorts at 550° and 600° C., the resultant charcoal being ideal fuel for suction gas producers. The vertical retort setting for carbonisation was of the Glover-West design, somewhat modified, as used in the tests already reported on the steaming process for gas-making from coal. Some difficulties were encountered, mainly of a mechanical order. The peat was not suitable for feeding with the ordinary arrangement, and the high percentage of dust which it contained on crushing gave trouble from its being carried forward into the gas main and forming a thick mass with the tar. A through-put of three tons of peat per retort was maintained.

After supplying sufficient heat for carbonisation of the peat there were for disposal from each ton of peat 7940 cubic feet of gas of 325 B.Th.U., 12·6 gallons of tar, 95½ gallons of liquor of 3·6 oz. strength per ton, and 5·4 cwt. of charcoal. The liquor was weak, and its quantity corresponded with some 27 lb. of ammonium sulphate per ton. The peat gas, which was very dense, contained 15 to 17 per cent. carbon dioxide, but it burned with a satisfactory flame though with only slight luminosity. A feature of the gas was the heavy sickly odour which it gave out on combustion. The light spirit amounted to nearly two gallons per ton of peat.

The report is supplemented by eight tables in which various thermal and chemical data are collected, including analyses of the peat and its products, and an examination of the tar oils. J. W. C.

University and Educational Intelligence.

ABERDEEN.—A special examination for ex-Service students has resulted in the capping of twenty-eight graduates in medicine—M.B. and Ch.B. degrees—of whom four are with distinction. The informal graduation ceremony was conducted on December 24 by the Vice-Chancellor, Principal the Rev. Sir George Adam Smith.

LEEDS.—The Council of the University has conferred upon Mr. W. E. H. Berwick the appointment of reader in mathematical analysis. Mr. Berwick has been lecturer in the department of mathematics of the University since October, 1920.

THE following elections to the scholarships in commerce have been made by the University of London:—Sir Edward Stern scholarships of 50*l.* a year for two years, W. W. Hewett and K. P. Rush. Sir Ernest Cassel scholarships of the value of not less than 200*l.* for the study of commerce in foreign countries, C. E. Benzecry, W. F. Crick, T. A. Hooker, and F. W Taylor.

THE *Chemical Age* announces that the trustees of the Ferguson Bequest Fund have unanimously approved the appointment of Mr. Henry Hyman to be the first Ferguson fellow for research in applied chemistry. The fellowship is of the annual value of 200*l.* for two years, and the research may be carried out at Glasgow University, the Royal Technical College, or elsewhere, as the fellowship committee may direct.

THE proprietors of the *Practical Engineer*, by arrangement with the International Correspondence Schools, are offering a scholarship in mechanical engineering of the value of 30*l.* The scholarship, which is open to subscribers to that periodical of all ages and both sexes, will be awarded to the candidate submitting the best essay on "Why I would Choose an Engineering Career To-day." Full particulars may be obtained from the *Practical Engineer* offices, 8 Breams Buildings, Chancery Lane, E.C.4.

THE British Federation of University Women is giving practical expression to its belief in international ideals by the offer of a travelling fellowship, value 300*l.*, which is open to members of all national federations of university women forming branches of the International Federation. The fellowship will be tenable for the academic year 1922–23, the main condition being that research or post-graduate study shall be undertaken in some country other than that in which the fellow has received her previous education or habitually resides. Full particulars can be obtained from the Secretary, British Federation of University Women, 73 Avenue Chambers, Vernon Place, W.C.1.

Calendar of Scientific Pioneers.

December 29, 1731. Brook Taylor died.—Educated at Cambridge and a man of means, Taylor was devoted to the arts and sciences, served as secretary to the Royal Society, and in 1715 published his "Methodus Incrementorum Directa et Inversa," a treatise dealing with the calculus of finite differences and containing the important theorem which bears his name.

December 30, 1644. Johann Baptista van Helmont died.—A student of medicine at Louvain, van Helmont settled on his estate near Brussels. Though imbued with the superstitions of his day, he was a careful experimenter, and is remembered for his early researches on various gaseous substances.

December 30, 1691. Robert Boyle died.—The son of an Irish earl, Boyle devoted his life to the advancement of science and the spread of religion. He made numerous additions to physics and chemistry, and his name is perpetuated by the well-known Boyle's law, discovered by him in 1662 and independently by Mariotte about 1676.

December 31, 1719. John Flamsteed died.—The first of a long line of distinguished Astronomers-Royal, Flamsteed began his observations at Greenwich on October 29, 1676, the erection of the observatory being directly due to the need for improving the means of finding the longitude at sea. Flamsteed investigated the fundamental points of astronomy and formed a catalogue of 2935 stars, but his "Historia Cœlestis" was not published in its complete form until 1725.

December 31, 1868. James David Forbes died.—For twenty-seven years professor or natural philosophy at Edinburgh, Forbes was best known for his researches on heat and on glaciers. Like Brewster, he was one of the founders of the British Association.

E. C. S.

Societies and Academies.

LONDON.

Geological Society, December 7.—Mr. R. D. Oldham, president, in the chair.—S. S. **Buckman**: Jurassic chronology: II., Preliminary studies. Certain Jurassic strata near Eype's Mouth (Dorset): the junction-bed of Watton Cliff and associated rocks. A detailed section is recorded of a white lithographic bed in Watton Cliff which shows faunal inversion. The dating of this bed is discussed, and a theory of stratal repetition and coalescence is discussed. Its main date is taken to be Yeovilian, *Hammatoceras hemera*. The white lithographic bed of Burton Bradstock is cited as evidence of stratal repetition, and a theory as to its deposition and partial destruction is put forward. Both beds are cited as evidence of Alpenkalk conditions prevailing in western Europe at two well-separated Jurassic dates, both of them earlier than the times of Alpenkalk deposits in central and eastern Europe. A new species of rhynchonellid from a deposit at Thorncombe Beacon is described.—J. **Stansfield**: Banded precipitates of vivianite in a Saskatchewan fireclay. The pale grey Tertiary fireclay worked for firebricks contains bluish-black patches, the central portions of which are deeply coloured and usually surrounded by a uniformly stained area or by several concentric stained layers of varying tint. The colour is due to an amorphous variety of vivianite, formed presumably by precipitation brought about by iron-solutions reacting on solutions of phosphates of organic origin, such solutions being brought together by diffusion through the colloidal clay. The spacing of the vivianite-bands is irregular, and appears to follow no known law.

Optical Society, December 8.—Mr. R. S. Whipple, president, in the chair.—L. C. **Martin**: The physical meaning of spherical aberration. Experimental determination of the intensity of light near the focus of a lens system shows that the "spurious disc" appearance persisted at the best visual focus, even with large amounts of aberration. Increasing the aberrations draws light from the central concentration and scatters it in the surrounding field; from measurements of the loss the necessity of restricting the phase residuals to within $\lambda/6$ is inferred. Spherical aberration produces marked asymmetry on each side of the focus.—F. L. **Hopwood**: An auto-stroboscope and an incandescent colour top. The production of a variety of stationary dark images, due to the eclipse of an incandescent wire by an adjacent cold wire or opaque object when both are revolving about a common axis, was described. The phenomena might be practically applied to the study of the behaviour of a rotating body by converting it into an auto-stroboscope.—J. W. **Gifford**: Achromatic one-radius doublet eyepieces. Eyepieces both of the Huygenian and the Ramsden types have been constructed from pairs of one-radius achromatic doublets with external plane surfaces to the flint lenses. They compare well with the German orthoscopes in definition, while the cost of production, since the same radius serves for each doublet, or in the case of the Ramsden throughout, is sensibly less. Such eyepieces are adapted either for the telescope or the microscope. By their use a more perfect achromatism is obtained, and also in both of them a flat field, very extensive in one case, likely to be useful in such operations as counting blood corpuscles, etc.

Association of Economic Biologists, December 9.—Sir David Prain, president, in the chair.—J. H. **Priestley**: The resistance of the normal and injured plant-surface to the entry of pathogenic organisms. When the protective surface of the flowering plant is injured the

first visible indication of healing is the deposit of fatty substances from the evaporating sap at the cut surface and their later transformation into a resistant substance of the nature of "suberin" or "cutin." The nature and origin of the protective layer in the exodermis of the root and the general distribution of the endodermis and its frequent transition through different structural stages are briefly described. Primary and secondary stages have different powers of resistance to the entry of pathogenic organisms; the importance of these considerations in relation to mycorhiza was indicated. After the cortical tissues of the root are isolated from the vascular strand by a secondary endodermis with suberin lamellæ *plus* casparian strip, fungi found penetrating cortical tissues only may be regarded as saprophytic rather than parasitic. In the stem the first line of protection against pathogenic organisms lies in the cuticle. Underground and submerged stems usually possess a well-developed endodermis. In some plants a functional endodermis, normally absent, can be developed by etiolation, and its occurrence has a profound influence on the structure of the plant. After a wounded parenchymatous surface has been blocked by the rapidly forming deposit of suberin the tissues beneath usually give rise to an active phellogen producing cork. The general principles underlying cork formation and the occurrence of cork in normal stems and roots are briefly reviewed. In many cases the occurrence of deep-seated layers of cork could be associated with their formation beneath functional endodermal cylinders.

Faraday Society, December 13.—Prof. A. W. Porter, president, in the chair.—A. O. **Rankine**: The structure of some gaseous molecules of which hydrogen is a constituent. Data relating to the viscosity of gases the molecules of which contain one or more hydrogen atoms provide means of obtaining some knowledge of the dimensions of the molecules. An examination of certain hydrogen compounds containing different numbers of hydrogen atoms leads to novel views of the arrangement of the atoms. The behaviour of the molecules in molecular collision is considered and tables are given of the "mean collision areas." Assuming that the atoms towards the end of each period of the periodic table are equal in size, it is probable that as the number of hydrogen atoms in the molecule increases their nuclei become more remote from the nucleus of the central atom. The retreat of the hydrogen nuclei is due to their mutual repulsion, and the effect eventually leads to the failure to form such molecules as BH_3 and AlH_3. A comparison is made of the relative dimensions of CH_4 and Kr, which prove to be of the same size to a degree within that of experimental errors. The identity of correspondence between CH_4 and NH_4 as compared with that between Kr and Rb, and the equality of domains occupied in corresponding crystals by NH_4 and Rb respectively are indicated. Estimates of molecular dimensions from viscosity measurements agree with these results.

Society of Glass Technology, December 14.—Dr. Morris W. Travers, president, in the chair.—I. **Masson**, N. F. **Gilbert**, and H. **Buckley**: A suggested method of investigating the viscosity of glass. Applying a modified form of Stokes's law to ocular measurement of the rate of fall of a metal sphere in a viscous fluid gives results in fair agreement with the X-ray measurement where the shadow of the sphere was projected on to a photographic plate. For molten glass alundum crucibles had been found satisfactory, with platinum or large nickel balls.—V. **Stott**: Note on pipettes. Pipettes should be adjusted for a particular delivery time, and they are unsatisfactory if the delivery time is too short or too long. A definite period should be allowed for drainage when graduating, testing, and using pipettes.—F. **Twyman**: The annealing of glassware and annealing without pyrometers. A piece of the glass to be annealed is introduced into the furnace among the articles to be annealed. It is elastically strained by a definite amount, sufficient stress being brought to bear to deform it. Periodically the stress is removed. As the temperature of the furnace is raised a time will come when the test-piece will not recover entirely, and from a record of the time during which the piece has been kept strained at a particular temperature and the extent to which it recovers its original position it would be possible to calculate the time of relaxation at the temperature. For practical purposes if it springs back on release by one-half its originally strained amount it has been half-annealed, and so on; this time is independent of whether the lehr has been kept at a constant temperature during the annealing or not. If the test-piece deliberately strained is annealed, then the other objects which have passed through the same temperature and were originally strained by want of annealing will become annealed simultaneously to the same degree.

Linnean Society, December 15.—Dr. A. Smith Woodward, president, in the chair.—F. A. **Potts**: The work of the Carnegie Institution in the marine biology of Samoa. The Island of Tutuila, its wooded cliffs, coral-reefs, and the fish fauna, were described, with illustrations taken under water.—G. C. **Bourne**: The Raninidæ, a study in carcinology. The Raninidæ, a family of the Decapoda Reptantia, have arisen independently from Astacuran ancestors. Although the endophragmal skeleton of the Raninidæ exhibits certain cancroid characters, it is much more nearly related to the macruran than to the bachyuran type. The "epistome" is the antennary sternum, and the mandibular sternum enters into the composition of the preoral ventral plate. It is proposed to place the Raninidæ in a separate tribe, Gymnopleura, defined as follows:—Anterior thoracic sterna broad, posterior sterna narrow and keel-like; posterior thoracic epimera largely exposed by reduction of the branchiostegite; female openings on coxæ; last pair of pareiopods dorsal in position, normal or reduced in size. Sternal canal present; thoracic nerve ganglion-chain elongate; antennary sternum triangular, spout-shaped; branchia 8 on each side. The respiratory mechanisms of the Raninidæ were described. The antennary flagella are usually short, but there are special arrangements for maintaining a respiratory current of water when the animals are covered with sand or mud, for they are burrowers; Notosceles shows adaptations to a swimming habit.

DUBLIN.

Royal Dublin Society, December 20.—Mr. G. Fletcher in the chair.—H. H. **Dixon** and N. G. **Ball**: Photosynthesis and the electronic theory, ii. Experiments were described showing that the sensitisation of photographic films to red light by chlorophyll and by a commercial sensitiser is effective at the temperature of liquid air. It has been previously shown that chlorophyll does not emit electrons when exposed to visible light in sufficient number to account for photosynthesis; hence the present experiments indicate that the effect of light is to cause a displacement of electrons within the chlorophyll molecule, thus rendering part of the molecule reactive. A new scheme of photosynthesis is suggested.—P. A. **Murphy**: The bionomics of the conidia of *Phytophthora infestans*.

Conidia in soil may retain their vitality under natural conditions for more than three weeks, and under artificial conditions for at least six weeks. Some of the more important factors governing this process, *e.g.* nature of soil, humidity, and temperature, were determined. The longer life of the conidia in soil as contrasted with air is attributed to the greater proportion of carbon dioxide and lack of oxygen in the former. Conidia and their products on germination were observed for periods of from two to five weeks under conditions tallying with those occurring in the soil; during these periods many remained alive and capable of infecting potatoes. The life of the fungus in water and soil is much extended when germ-tubes are formed; the same end is attained when zoospores result, for these can give rise directly to diminutive conidia.

SYDNEY.

Linnean Society of New South Wales, October 26.—Mr. G. A. Waterhouse, president, in the chair.—Vera **Irwin-Smith**: Studies in life-histories of Australian Diptera Brachycera. Pt. 1: Stratiomyiidæ. No. 3: The structure of the mouth-parts and pharynx of the larval *Metoponia rubriceps*. Morphological studies of the mouth-parts and pharynx of larval *M. rubriceps*, which lives on the juices in the roots of grasses, are described.—R. J. **Tillyard**: A new genus and species of May-fly (order Plectoptera) from Tasmania, belonging to the family Siphluridæ. The new genus is closely allied to the genus Oniscigaster found in New Zealand, from which it differs in its smaller size, in the complete absence of the appendix dorsalis in both sexes, and in the larval habit of living in still water.—G. F. **Hill**: New and rare Australian termites, with notes on their biology. Ten species are described, five of them being new. The number of described species of Australian termites is now approximately 115.—R. J. **Tillyard**: Two fossil insect wings in the collection of Mr. John Mitchell, from the Upper Permian of Newcastle, N.S.W., belonging to the order Hemiptera. The impressions are in association with Glossopteris fronds. The smaller belongs to a new family, genus and species of the division Sternorrhyncha of the sub-order Homoptera. The larger is a hindwing of a new genus and species allied to Prosbole from the Upper Permian of Russia, and belonging to the sub-order Palæohemiptera, now extinct. Evidently in Upper Permian times the sub-order Homoptera was already divided into its two main divisions, whereas the Heteroptera proper had not yet appeared, being represented only by the Palæohemiptera.—T. **Steel**: Chemical notes: Botanical. Analyses are recorded of some Australian fruits and of Fijian wild sugar-cane and the roots of the dragon-tree. Notes on the deposit of calcium carbonate in timber of *Geissois Benthami*, F. v. M., and the percentage of nitrogen in Australian fungi are also given.

Royal Society of New South Wales, November 2.—Mr. E. C. Andrews, president, in the chair.—A. R. **Penfold** and M. B. **Welch**: Two pinnate-leaf Boronias and their essential oils, with description of a new species. *Boronia pinnata*, common on the sandstone ridges north and south of Sydney, and *B. thujona*, with thin velvety leaves, found only in dense undergrowth in moist situations, were described. The principal constituent of the essential oil of *B. pinnata* is an unidentified terpene, resembling limonene, whilst the oil of *B. thujona* consists essentially of *α*- and *β*-thujone.—F. R. **Morrison**: The occurrence of rutin in the leaves of the Boronia (N. O. Rutaceæ). The yellow dye material was obtained from the leaves of the native rose, *B. serrulata*, and from *B. pinnata* and *B. thujona*. The yield of crude rutin varied from 0·7 to 1·6 per cent. The colours produced on mordanted cloth were similar to those produced by rutin from other sources. This dye was first isolated from *Ruta graveolens*, which belongs to the same natural order as the Boronias.—T. H. **Harrison**: Note on the occurrence in New South Wales, Australia, of the perfect stage of a Sclerotinia causing brown rot of fruits. Review of climatical conditions leading to production of apothecia. Apothecia arose from mummified apricots in an orchard at Pennant Hills, near Sydney, N.S.W. Inoculations of loquat with cultures from an apothecium produced typical brown-rot lesions. The organism is probably *Sclerotinia fructigena*.

LAHORE.

Philosophical Society, June 15.—Dr. B. Sahni, president, in the chair.—S. K. **Pandé**: Some observations on a rust on *Euphorbia tibetica*. The diseased plants were collected in Ladakh (Kashmir). In its structure and its effects on the host the fungus resembles some species of Uromyces. The fungus causes marked changes in the habit of the host; the growth becomes stunted, the leaves become broader, and the production of flowers is retarded.—B. **Sahni**: Preliminary account of a petrified palm-stem (Palmoxylon sp.) from the Tertiary rocks of Jammu. The transverse section shows numerous scattered fibro-vascular bundles in a loose parenchyma. There are no fibrous bundles between the vascular strands.

June 20.—Dr. B. Sahni, president, in the chair.—G. **Matthai**: General account of a marine biological excursion to Karachi during December, 1920, and January, 1921. The different groups of animals in the collection were described as follows:—I. M. **Puri**: The Nemerteans.—H. **Singh**: The birds.—A. **Kumar**: The sponges, polyzoa, and ascidians.—G. R. **Kohly**: The brachyura and anomura.—A. **Chand**: The polychætes and gephyreans.—G. **Matthai** and M. L. **Bhatia**: The nudibranch mollusca.—I. **Ali**: The fishes.—G. **Sondhi**: The lamellibranch mollusca.—D. **Ram**: The chætognatha.—G. **Matthai**: The hydrozoa and anthozoa.—S. **Singh**: The entomostraca.

Diary of Societies.

THURSDAY, DECEMBER 29.

ROYAL INSTITUTION, at 3.—Prof. J. A. Fleming: Electric Waves and Wireless Telephony: Surface Waves on Liquids.

HEALTH, MATERNITY, AND CHILD WELFARE LEAGUE (at University College), at 5.—Prof. Winifred Cullis: The Significance and Problem of Growth.

ROYAL DRAWING SOCIETY (at University College), at 5.30.—Miss D. M. Wilkins: The Affinity of Science with Art.

HEALTH, MATERNITY, AND CHILD WELFARE LEAGUE (at University College), at 6.—The Growth of the Mind.

INSTITUTION OF AUTOMOBILE ENGINEERS (at 28 Victoria Street), at 7.30.—Adjourned Discussion on Paper by H. F. L. Orcutt: Motor-car Gear-boxes.

FRIDAY, DECEMBER 30.

HEALTH, MATERNITY, AND CHILD WELFARE LEAGUE (at University College), at 5.—The Physiology of Adolescence and its Physical Requirements; at 6.—The Psychology and Mental Management of the Adolescent.

INSTITUTION OF PRODUCTION ENGINEERS (at Institution of Mechanical Engineers), at 7.30.—G. H. Hales: The Costing System and its Relation to Production.

JUNIOR INSTITUTION OF ENGINEERS, at 8.

SATURDAY, DECEMBER 31.

CONFERENCE OF EDUCATIONAL ASSOCIATIONS (Joint Conference) (at University College), at 10.30 a.m.—Dr. J. C. Maxwell Garnett and Prof. J. Strong: Education as a Science.

ROYAL INSTITUTION, at 3.—Prof. J. A. Fleming: Electric Waves and Wireless Telephony: Waves in Air.

MONDAY, JANUARY 2.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at University College), at 2.30.—Prof. T. H. Pear: Mental Tests and Mentality.

ROYAL GEOGRAPHICAL SOCIETY (Christmas Lectures to Young People) (at Æolian Hall), at 3.30.—Miss Ella Sykes: A Ride on the Roof of the World.

CENTRAL ASSOCIATION FOR THE CARE OF THE MENTALLY DEFECTIVE (at

University College), at 5.—Miss Lucy G. Fildes: The Training of Teachers for Mentally Defective and Backward Children, and Special Methods of Teaching.

MATHEMATICAL ASSOCIATION (at London Day Training College), at 5.30.—Sir George Greenhill: Mathematics in Artillery.

TUESDAY, JANUARY 3.

MATHEMATICAL ASSOCIATION (at London Day Training College), at 10 a.m.—Dr. J. W. Nicholson: The Structure of the Atom.—Prof. C. Godfrey: Vectors.—Miss F. A. Yeldham: The Dalton Plan and the Teaching of Mathematics.

SCIENCE MASTERS' ASSOCIATION (at Imperial College of Science and Technology), at 11 a.m.—The Master of Balliol: Science and History (Presidential Address); at 12.—T. J. Gardner and others: Discussion: The Teaching of Mechanics.

ASSOCIATION OF SCIENCE TEACHERS (at University College), at 2.30.—Dr. Winifred Brenchley: The Effects of Competition on Plant Life.

MATHEMATICAL ASSOCIATION (at London Day Training College), at 2.30.—Prof. G. H. Hardy: The Late Srinivasa Ramanujan.—A. Dakin and others: Discussion: That Pure and Applied Mathematics ought to be Taught and Developed *pari passu* in Boys' Secondary Schools.—Rev. E. M. Radford and others: Discussion: How to Keep Teachers of Mathematics in Touch with Modern Developments and Methods.

ROYAL INSTITUTION, at 3.—Prof. J. A. Fleming: Electric Waves and Wireless Telephony: The Telephone.

SCIENCE MASTERS' ASSOCIATION (at Imperial College of Science and Technology), at 3.—D. Berridge and others: Discussion: The Teaching of Geography in Relation to Science.

SCHOOL NATURE-STUDY UNION (at University College), at 3.—Dr. E. J. Russell: The Soil and Plant Growth.

EUGENICS EDUCATION SOCIETY (at University College), at 5.—W. Hope-Jones: A Eugenic View of Education.

HEALTH, MATERNITY, AND CHILD WELFARE LEAGUE (at University College), at 5.—Special Diseases and Disabilities of Adolescence; at 6.—Dr. C. W. Saleeby: The Social Problem of the Adolescent.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Lecture.

WEDNESDAY, JANUARY 4.

SCIENCE MASTERS' ASSOCIATION (at Imperial College of Science and Technology), at 12.—Brig.-Gen. H. B. Hartley and others: Discussion: Physical Chemistry in Schools; at 3.—Major E. R. Thomas and others: Discussion: Post-certificate Science for Non-specialists.

SOCIETY FOR EXPERIMENT AND RESEARCH IN EDUCATION (at University College), at 3.—Prof. H. Laski: The Needs of the Modern University.

PHYSICAL SOCIETY AND OPTICAL SOCIETY (at Imperial College of Science and Technology), at 4.—A. A. Campbell Swinton: The Johnsen-Rahbek Electrostatic Telephone and its Predecessors.

CHILD-STUDY SOCIETY (at University College), at 5.—Dr. Rusk: The Supernormal Child.

HEALTH, MATERNITY, AND CHILD WELFARE LEAGUE (at University College), at 5.—Athleticism and Adolescence.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. W. D. Lang, Dr. L. F. Spath, and W. A. Richardson: Shales-with-Beef, a Sequence in the Lower Lias of the Dorset Coast.

ROYAL SOCIETY OF MEDICINE (Surgery Section), at 5.30.—Lockhart Mummery and others: Discussion: Pulmonary Infaration following Operations.

HEALTH, MATERNITY, AND CHILD WELFARE LEAGUE (at University College), at 6.—Miss Norah March: Sex Instruction of the Adolescent.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—Lt.-Col. A. G. T. Cusins: High-speed Wireless Telegraphy.

PHYSICAL SOCIETY AND OPTICAL SOCIETY (at Imperial College of Science and Technology), at 8.—F. H. Glew: Radium: Its Application in Peace and War.

THURSDAY, JANUARY 5.

GEOGRAPHICAL ASSOCIATION (at Birkbeck College), at 11.45 a.m.—R. L. Thompson and others: Discussion: Geography and History in Schools.

ASSOCIATION OF ASSISTANT MASTERS IN SECONDARY SCHOOLS (at London Day Training College), at 2.30.—Prof. T. P. Nunn: The Purposes of Education.

GEOGRAPHICAL ASSOCIATION (at Birkbeck College), at 2.30.—Sir Halford J. Mackinder: Problems of the Pacific.

ROYAL INSTITUTION, at 3.—Prof. J. A. Fleming: Electric Waves and Wireless Telephony: Electric Oscillations.

GEOGRAPHICAL ASSOCIATION (at Birkbeck College), at 4.—E. N. Fallaize: The Anthropological Institute and the Services it can render to Geographical Students.

CENTRAL ASSOCIATION FOR THE CARE OF THE MENTALLY DEFECTIVE (at University College), at 5.—Dr. G. A. Auden: The Possibility of Co-operation between the School Medical Officer and the Teacher in the Training of Subnormal and Mentally Defective Children.

LONDON HEAD TEACHERS' ASSOCIATION (at University College), at 5.30.—D. J. Collar and T. G. Tibbey: Intelligence Tests in Schools.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Wing-Cmdr. W. D. Beatty: Specialised Aircraft.

GEOGRAPHICAL ASSOCIATION (at Birkbeck College), at 5.45.—Lord Robert Cecil: Presidential Address.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Dr. S. P. Smith: Single and Three-phase Commutator Motors with Shunt and Series Characteristics.

PHYSICAL SOCIETY AND OPTICAL SOCIETY (at Imperial College of Science and Technology), at 8.—A. A. Campbell Swinton: The Johnsen-Rahbek Electrostatic Telephone and its Predecessors.

FRIDAY, JANUARY 6.

GEOGRAPHICAL ASSOCIATION (at King's College), at 10.20 a.m.—Dr. Fleure: The Co-operation of Historians and Geographers.

GEOGRAPHICAL ASSOCIATION (at Birkbeck College), at 3.—Miss L. Winchester: Some Climate Problems of Modern Palestine.

ROYAL GEOGRAPHICAL SOCIETY (Christmas Lectures to Young People) (at Æolian Hall), at 3.30.—Sir Francis Younghusband: Pictures from Mount Everest.

GEOGRAPHICAL ASSOCIATION (at Birkbeck College), at 4.—Dr. Hogarth: The Hedjaz.

INSTITUTION OF MECHANICAL ENGINEERS (Joint Meeting with the Society of Chemical Industry), at 6.—G. M. Gill: The Co-operation of the Engineer and Chemist in the Control of Plants and Processes.

SATURDAY, JANUARY 7.

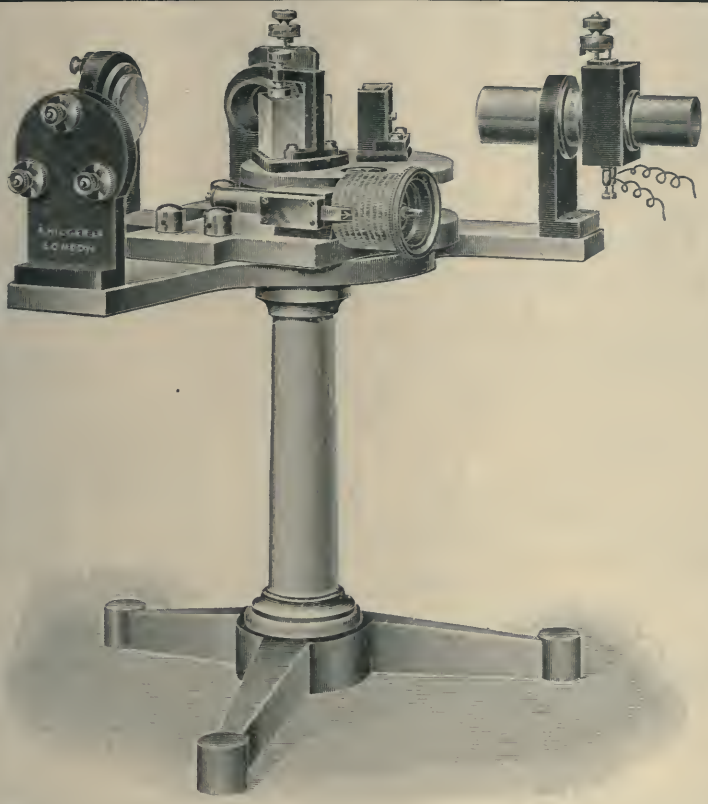
COLLEGE OF PRECEPTORS, at 11.30 a.m.—Prof. J. Adams: Psychoanalysis and its Value and Limitations from the Standpoint of the Practical Teacher.

ROYAL INSTITUTION, at 3.—Prof. J. A. Fleming: Electric Waves and Wireless Telephony: Electric Waves.

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.1), at 3.—E. Kay Robinson: British Wild Life.

CONTENTS.

	PAGE
Smoke Abatement	557
Christian Theism. By The Rev. Dr. F. R. Tennant	559
Domestic Heating and Waste of Coal and Health. By L. H.	560
Metallurgical Principles and Processes. By Prof. C. H. Desch	562
Our Bookshelf	563
Letters to the Editor:—	
The Accessory Nature of many Structures and Habits Associated with Courtship.—Julian S. Huxley	565
Terrestrial Magnetic Disturbances and Sun-spots.—J. Evershed, F.R.S.	566
Microscope Illumination and Fatigue.—J. E. Barnard	566
Prismatic Structure in Optical Glass. (*Illustrated.*)—Dr James Weir French	567
The Calendar of Scientific Pioneers.—Eng.-Comdr. Edgar C. Smith, R.N.	567
The Electric Telegraph.—J. C. Carter; The Writer of the Note	568
The Hydrogen-ion Concentration of the Soil in Relation to Animal Distribution.—Dr. W. R. G. Atkins	568
Relativity and Materialism.—Dr. Harold Jeffreys; S. V. Ramamurty; Dr. Norman R. Campbell	568
The Resonance Theory of Hearing.—Dr. W. Perrett	569
Next Year's Total Solar Eclipse (September 21, 1922). (*With Diagram.*) By Major William J. S. Lockyer	570
Spontaneous Combustion of Coal in Mines	572
Countries as Personalities. By Prof. H. J. Fleure	573
Obituary	575
Notes	576
Our Astronomical Column:—	
The January Meteors	580
The Furthest Cluster	580
Prize Awards of the Paris Academy of Sciences for 1921	581
Anthropology at the British Association	582
Valency Bonds and the Mechanism of Organic Reactions. By H. M. D.	584
Agriculture in the Maryut District, West of Alexandria	585
Fisheries Biology. By J. J.	585
The Need for Research in Colloid Chemistry. By William Clayton	586
Orientation in Egypt. By Col. H. G. Lyons, F.R.S.	587
Experiments on Plague Eradication in India	587
The Carbonisation of Peat in Vertical Gas Retorts. By J. W. C.	588
University and Educational Intelligence	588
Calendar of Scientific Pioneers	589
Societies and Academies	589
Diary of Societies	591



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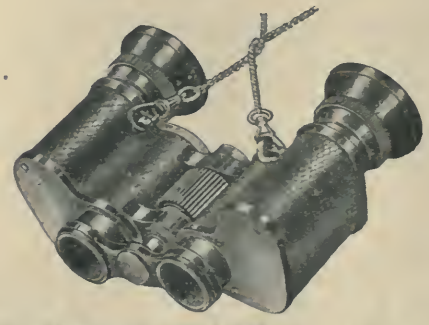

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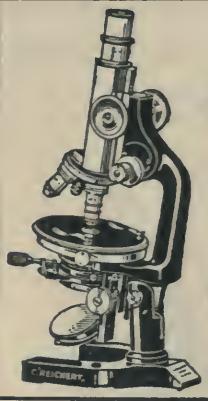

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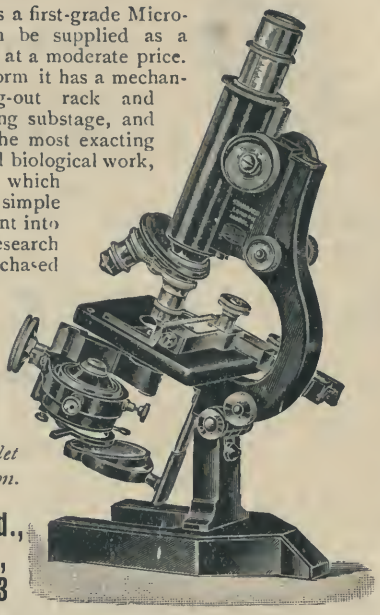

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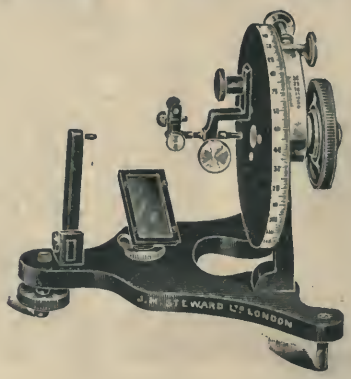

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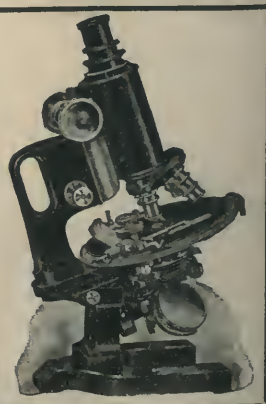

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